

JOHNSTON ATOLL
TRU SOIL CLEAN-UP PROJECT
DRAFT

ASSEMBLY & DEMONSTRATION
OF THE
"TRUclean" SOIL CLEAN-UP PLANT



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JA TRUclean REPORT

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APPENDIX I

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1.0 INTRODUCTION

The objectives of this project were to design, assemble and operationally test a soil decontamination production plant for remediation of plutonium contaminated soils on Johnston Island, Johnston Atoll. The purpose of the plant is to reduce the volume of soils that require radiological controls by physically separating the original soil into two parts -- a small volume of contaminated soil and a much larger volume of uncontaminated soil that requires no restrictions on its use.

The soil decontamination concept was first demonstrated on a pilot plant scale at Johnston Atoll in 1985 and 1986. For these demonstrations an overall volume reduction factor of 98% was achieved, based on the volume of soil processed versus the volume of decontaminated soil. That is, the specific activity of 98% of the contaminated soil was reduced to less than 500 Bq/Kg, which was the guideline established by the Defense Nuclear Agency for unrestricted use. The other 2% of the soil contained 97% of the starting activity (Su86).

The design parameters for the production plant were:

1. Capability to safely decontaminate soil of transuranium (TRU) contamination at rates up to approximately 100 cubic yards of soil per day for up to 100 consecutive weeks.
2. To the extent practicable, allow for easy and efficient dismantling, decontamination, repackaging for transport following project completion and reassemble at sites other than Johnston Atoll.
3. Capability to decontaminate Johnston Atoll soil of TRU to levels as low as is reasonably achievable and in any case to levels no more than 500 Becquerels of TRU per kilogram of soil (500 Bq/Kg) averaged over any 0.1 cubic meter of soil and with no "hot" TRU particles in any 0.01 cubic meters exceeding 5 kiloBecquerels (5 kBq), and further is capable of soil decontamination to these standards for a least 95% by volume of soil processed with less than 5% by volume remaining contaminated for radioactive waste disposal.
4. Include a sorting system capability to sort soil into contaminated and clean fraction based on the limits specified above at a sorting rate of 100 cubic yards per day.

A plant operational demonstration was conducted between February 6th and March 20th, 1989. This demonstration allowed evaluation of the plant's performance relative to design parameters. The plant design throughput of 100 cubic yards per day was demonstrated on several occasions with a maximum throughput of 119 cubic yards for eight hours of plant operation demonstrated on March 15, 1989.

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The monitoring system on the pilot plant consisted of a manual monitoring system with manual diversion of material. In the production plant the monitoring system was upgraded to a computer controlled monitoring system and computer controlled diversion system. The computer firmware and software programs for the counting system were complex and required considerable effort to resolve logic and program discrepancies. The patience and effort however, were rewarded by a very effective, stable, sensitive and state-of-the-art counting system. The system was capable of monitoring and sorting soil at a rate of 100 cubic yards per day and at a detection level of 500 Bq/Kg for uniformly contaminated soil. The system also successfully detected "hot" 5 kBq particles simultaneously and provided properly timed diversion signals for both detection criteria. 13.5 pci/g

During the operational demonstration a large stockpile of clean soil was generated. The radioactivity removed from the soil by the gravimetric process was concentrated into a volume representing 1.1% of the total volume of soil processed by the plant. The diverted material, which consisted of particles attached to coral or low density particles, was greater in volume than projected from pilot plant data. A concept to further reduce this volume was tested, and indicated this volume could potentially be reduced to 0.7% of the total soil volume processed. Combining these two volumes results in a contaminated fraction representing 1.8% of original soil volume.

Preliminary measurements on the pond sludge, which represents an estimated 3.3% of the original soil volume, indicate it is borderline for clean criteria. Further analysis and investigation of alternative handling techniques will be required to determine final disposition for this material.

2.0 SITE HISTORY

Johnston Atoll is located 1150 km west-southwest of Honolulu, Hawaii. The Atoll consists of a group of four coral islands. The largest island, Johnston Island (JI), has about 256 hectares (ha) of land area. During 1958 to 1962 JI was used as a launch facility for missiles in the U.S. atmospheric nuclear weapons test program. The atoll was contaminated with plutonium in 1962 as a result of three THOR missile aborts. One abort occurred on the launch emplacement (LE-1) and two were aborted at elevations of 9,100 and 33,200 meters above the atoll.

Following the launch emplacement mishap, the LE-1 area was hastily decontaminated by removing contaminated coral, stabilization of contamination and removal of contaminated debris. The launch facilities were decommissioned in 1977 and major system components were decontaminated and removed from the site. In 1983 a program was initiated to decontaminate remaining structures (DO83). Contaminated structures were dismantled, decontaminated and waste concrete and steel were shipped to a radioactive waste disposal facility.

Several surveys in subsequent years indicated contamination hot spots remained outside the launch emplacement area and throughout the

LE-1 area. In 1980, measurements of plutonium soil contamination were conducted over all land areas of Johnston Atoll (JA81). Measurements were made with a collimated high purity germanium (HPGe) detector suspended 7.4 m above the ground surface. This aerial arrangement resulted in a survey of a circular area 25 m in diameter.

Based on this survey, areas containing contaminated soil outside the Radiological Control Area (RCA) were identified and the contaminated soil was removed and relocated to the RCA. At present, the contamination on Johnston Island is located in a 9 ha site on the North side of the island, designated as the RCA, which encompasses the original LE-1 and LE-2 launch areas. This area presently contains an estimated 100,000 cubic meters of coral soil contaminated with plutonium (BR88).

In 1984, as part of an effort to further reduce radioactive contamination, laboratory scale tests were performed to determine if the plutonium contamination could be readily separated from the coral soil. These tests involved froth flotation, ferrite treatment, attrition-scrubbing, ultrasonic treatment and dry sieving. The tests indicated that dry sieving might reduce the volume of contaminated soil by as much as 50% and that froth flotation could reduce the remaining contaminated soil by an additional 35% (BR88).

In 1985 proposals were sought for pilot plant demonstrations of soil decontamination processes for Johnston Atoll. A process proposed by AWC, Inc. to take advantage of the large density difference between plutonium and coral soil (gravimetric separation) was selected for the pilot plant demonstration.

3.0 THE TRUclean PROCESS

3.1 Development Work & Pilot Plant

The TRUclean¹ process was developed in 1984 by James W. Ayres and Alfred W. Western, owners of AWC, Inc. in Las Vegas, Nevada and utilizes a gravimetric separator to concentrate radioactive particles which have a corresponding higher density with respect to their host soil. In 1985 the AWC TRUclean process was selected for demonstrating the decontamination of the soils on Johnston Atoll. In late, 1985 AWC designed and installed a TRUclean pilot plant in Building 795 at Johnston Island and operated the plant through June of 1986. During the pilot plant program, a total of 600 cubic meters of soil was processed through the system resulting in clean soil with plutonium activity levels below 500 Bq/kg. The activity removed from the soil was concentrated into 10% of the original soil volume. Processing this concentrate through the plant a second time reduced the contaminated soil fraction to about 2% of the original volume.

The TRUclean pilot plant system was moved to the Nevada Test Site (NTS) and tested on contaminated soil from several Department

1) Patent

of Energy (DOE) sites in the continental United States — the Nevada Test Site (NTS); the Rocky Flats Plant (RFP) in Colorado; the FUSRAP site at Hazelwood, Missouri; the Monsanto-Mound site in Ohio, and the Fort Dix site in New Jersey. Generally, activity reduction factors of around 90 percent could be achieved for the removal of contaminants such as plutonium, thorium, uranium, and radium, with the processed soils having radioactive concentrations less than the guideline established by the Defense Nuclear Agency and the Department of Energy. The volume reduction achieved was highly dependent on soil and contaminate characteristics. Time and budget restraints did not allow custom tailoring the TRUclean process for a specific soil type. Despite this, volume reduction factors of 45% to 99% were achieved using pilot plant equipment which was designed to concentrate the plutonium in Johnston Island coral, (Su87a), (Su87b), (Su87c), (Su87d), (Su87e).

3.2 TRUclean Production System

The following is a brief description of the production system, equipment, components, and their functions. The plot plan, Figure 1 shows the relative location of each production system component and cross references the equipment number to this description for ease of identification.

Coral sand to be processed through the plant is loaded on the grizzly screen (#30). Coral pieces larger than 8 inches in diameter are rejected by the grizzly screen and roll off onto the ground on the back side of the grizzly. Pieces smaller than 8 inches pass through the screen and are collected in the bin. The belt feeder at the bottom of the bin is driven by a variable speed motor which allows control of the feed rates of coral to the remainder of the system.

Coral then moves up the feed conveyor (#31) and across a weight belt scale which measures the amount of material entering the system. Coral from the feed conveyor falls into the vibrating screen (#32a) for sizing. The vibrating screen divides the coral into three size fractions: 1" to 8" in diameter, 3/16" to 1" in diameter, and less than 3/16" in diameter. The size fraction between 1" and 8" is routed to the oversize conveyor (#32b) and stock piled on the ground. The size fraction between 3/16" and 1" is routed to the hammermill crusher (#32c) for size reduction to less than 3/16". After sizing in the hammermill, the material falls to the sorter feed conveyor (#32d). Coral which is less than 3/16" falls through the screen directly to the sorter feed conveyor.

The coral is then transported by the sorter feed conveyor over another weigh belt scale to determine the amount of coral entering the sorter section of the plant. At the end of the sorter feed conveyor the coral stream is divided into two equal streams before entering two short sorting conveyors (#34 & #35). Each of these two sorting conveyors contains a leveling gate which spreads the coral across the conveyor belt to a thickness of 3/4". The coral then passes under an array of sodium iodide (NaI) detectors to measure

the americium-241 content of the coral. Signals from the NaI detectors are processed by a computer system in the control room at Building 795 to determine if coral contamination exceeds 500 Bq/Kg or a hot particle exceeding 5000 Bq is present. If activity exceeds these contamination levels, a signal is sent to the gate at the end of the sorting conveyor belts (#36 & #37) to direct the coral to the TRU diverted conveyor (#39). If activity is less than the contamination limits, a signal is sent to the gate to divert the coral to the clean conveyor (#38). Coral is transported by the clean conveyor to the stacker conveyor (#40) which moves it to a stockpile area.

Contaminated coral from the TRU diverted conveyor enters the TRU feed conveyor (#33) and is elevated to the top of the elevated storage bin (#1) where it is collected to await processing through the decontamination plant.

Coral from the elevated storage bin is metered onto the feed conveyor (#7) using a slide gate at the bin discharge cone. The slide gate and variable speed drive on the feed conveyor allows control of the feed rate to the decontamination plant. A weight belt scale on the feed conveyor measures the amount of coral entering the decontamination plant.

Coral from the feed conveyor enters the feed chute of the gravimetric separators (#9 & #10) where water is mixed with the contaminated coral. The resulting coral slurry travels over a set of riffles where large pieces of plutonium oxide are trapped. The coral slurry then enters the gravimetric separators where separation of the plutonium oxide occurs. The plutonium oxide and a portion of the coral sinks through the bed of the gravimetric separator and flows in the form of a slurry to the supply pump P-4 (#44) where it is transferred into Building 795 for further concentration in another gravimetric separator called the cleaner separator circuit.

The clean coral overflows the gravimetric separator (#9 and #10) and passes into the dewatering augers (#11 & #11a). Water is separated from the clean coral by the auger and enters a pair of sorting conveyors (#12 & #13). Each sorting conveyor as in the sorter plant, contains a leveling gate which spreads the coral on the conveyor belt to a thickness of 3/4". The coral then passes under an array of NaI detectors to measure the americium-241 contents of the coral. Signals from the detectors are processed by the computer system to position the diverter gates (#20 & #21) to direct the material to the clean conveyor (#14) if no contamination is found above release limits or to divert the material from the system if excessive contamination is found. The clean coral travels from the clean conveyor to the stacker conveyor (#15) and is accumulated in a radial stockpile.

The cleaner separator circuit (inside Building 795) receives the concentrate from the gravity separators via pump (#44) and introduces it to the inlet of the cleaner gravimetric separator (#16) for the final stage of concentration. The clean tails from

the cleaner gravimetric separator is received by pump P-5 (#45) and returned to the feed chute of the main gravimetric separators (#9 & #10). The concentrate from the cleaner gravimetric separator drains to the pump P-3 (#43) for transfer to the concentrate dewatering auger (#19). The dewatering auger separates the final concentrate from the water and delivers it to a container for assay and storage. Overflow water from the dewatering auger flows to the agitator tank (#18) and is routed as required via the agitator pump P-6 (#46).

Water from the overflow weir on the dewatering screws (#11 & #11a) is pumped to lined settling ponds utilizing the pump P-2 (#42). All process water is obtained from the ponds and is supplied by pump P-1 (#41). When necessary, small amounts of make-up water are added to the ponds to maintain an adequate reservoir.

3.3 Theory of Operation

The TRUClean process uses a gravimetric separator to concentrate plutonium found in the Johnston Island soil. A simplified diagram of the gravimetric separator is shown in Figure 2.

The gravimetric separator basically consists of an open tank which is filled with water. A screen supporting a bed of steel shot is located about six inches below the water level. The steel shot forms a support layer for the coral and is referred to as the artificial bed material. As coral enters the gravimetric separator, it forms a layer above the steel shot and is referred to as the natural bed. The bed of coral in the gravimetric separator is loosened and compacted by action of the pulsating diaphragm. When the diaphragm moves up, it compresses the water cavity under the beds and produces an upward pulse of water through the bed, loosening the bed. When the diaphragm moved down, it draws the water through the bed causing the bed to compact. The alternating loosening and compaction of the bed arranges the coral and its contaminants in layers, with the less dense particles toward the top and the more dense particles toward the bottom of the natural bed. The concentrate or dense particles eventually work their way through the steel shot and fall into the hutch where they are removed through the discharge valve. The overflow discharge from the gravimetric separator is dewatered by a spiral classifier and the water is recycled in a closed loop system.

The gravimetric separator operates on principles developed from the study of particle behavior within a fluid. Early researchers noted that two particles of the same weight, but of different densities (for example, a small particle of gold and a larger particle of black sand of the same weight), reached very nearly the same speed during settling. However, it was observed that although these dissimilar particles reached nearly the same maximum speeds while falling through water, their initial accelerations were quite different. That is, the smaller, heavier particles (such as gold and lead) reached their maximum speed much sooner than the larger, lighter particles. This discovery led to the development of a pulsating bed for the separation of heavy material from a soil

matrix, whereby the particles were repeatedly raised and then dropped. Differential acceleration is the initial acceleration which is experienced by the particle when the motion of the fluid in which it rests is changed. If the duration of the fluid motion change is short enough so the terminal velocity of the particle is not reached, the distance the particle travels is relative to their initial acceleration. The initial acceleration of the particle will then be dependent only on the relative densities of the particles and stratification takes place based on their densities.

In order for the particles to maintain their new position after each pulse, it was found that the bed should be operated in a crowded condition, whereby all the particles in the bed are in close contact with other particles.

Hindered settling occurs when the crowded condition of solids reaches the point that interaction between adjacent particles becomes important and the bed behaves as a viscous liquid with a density more like the bulk density of the bed than the density of the water. Because the particle settling velocity is proportional to the difference in density between this pseudo fluid and the particle, the settling velocity of the less dense particles decreases more than that of the dense particles, thereby enhancing the separation.

Interstitial trickling occurs when the bed is compact and the larger particles bridge and interlock. During interstitial trickling only smaller particles can make their way through the spaces between larger particles. Interstitial trickling is an important mechanism whereby the small dense particles are moved toward the screen and hutch.

The shot supports the bed of material in the separating chamber, seals the screen openings, and directs the water currents necessary for effective separation. The bed is loosened by the water when the diaphragm moves up and compacted when the diaphragm moves down. This alternating loosening and compaction permits the heavy particles to migrate downward and keep the soil particles and other lighter materials in suspension. The heavier material in its downward travel passes through the bed of shot and then through the openings in the screen to be deposited in the hutch. The lighter materials follow the overflow into the discharge.

3.4 Monitoring Systems

Two counting systems are used to measure the amount of plutonium in coral soils. The first counting system is used to sort coral soils into contaminated and clean fractions following feed sizing. The second counting system is used to monitor the effluent from the decontamination plant. Each counting system contains thirty (30) sodium iodide detectors which are divided into two (2) detector modules, each containing fifteen (15) detectors. Each detector module is positioned 2.54 cm above an 84 cm wide conveyor belt in a detector array shown in Figure 3. Each sodium iodide

detector is 10 cm x 10 cm by 2 mm thick with a 0.025 cm aluminum window covering the detector face. Coral soil is spread to a 1.9 cm depth on the conveyor belt and passes under the detectors at a rate of 10.4 cm/sec. Each detector module is shielded on the sides and top with 0.63 cm of lead to reduce ambient background radiation counts. The thin crystal has a low efficiency for higher energy gamma ray photons which are present in the background spectrum and thus gives a lower background in the 60 keV region of the spectrum. A thicker crystal with higher efficiency for these higher energy gamma ray photons would have a corresponding higher bremsstrahlung in the 60 keV region.

A block diagram of the counting system is shown in Figure 3. Each detector signal is amplified and processed through a group of three single channel analyzers (SCA). The center SCA monitors the accumulating counts from region centered on the 60 keV gamma of americium-241. The other two SCAs monitor the region just above and just below the 60 keV peak for background subtraction options.

Gamma photons incident on a NaI detector result in a voltage pulse from the photomultiplier tube which is proportional in amplitude to the energy of the incident gamma. These pulses are amplified and routed to the SCAs. Each SCA has an adjustable upper and lower discriminator which provides a window for accepting voltage pulses of specified amplitude. Each SCA processes only those voltage pulses which fall within the respective window settings.

Figure 4 is a typical Am-241 gamma spectrum of count rate verses voltage. The shaded area between 2.8 and 3.0 volts represents the amplitude of voltage pulses which the lower SCA will process. Voltage pulses between 3.0 and 5.5 volts are input for the middle SCA and voltage pulses between 5.5 and 7.0 volts are input for the upper SCA.

Each voltage pulse processed by a SCA is sent to two separate buffers in the microprocessor firmware for storage. One buffer stores the number of voltage pulses for the hot particle determination and the second buffer stores the number of voltage pulses for the determination of distributed contamination. The computer operator inputs the length of storage time in each buffer. When each buffer reaches its preset storage time, the accumulated number of voltage pulses in the buffer is sent to the main computer for data processing. For the 15 detector array, a total of 45 buffers collect and send their data to the computer for each distributed storage time. An additional 45 buffers collect and send their data to the computer for each hot particle storage time.

The computer software allows three options for background subtraction.

1. Calculate background using upper and lower SCA
2. Calculate background using upper SCA only
3. Constant background

In Option 1 the number of voltage pulses in the upper and lower SCA buffers are normalized to the window width of the middle SCA. For example, the middle SCA has a window width of 2.5 volts (5.5-3.0) and the lower SCA has a window width of 0.2 volts (3.0-2.8). The number of voltage pulses in the lower SCA are normalized to the middle SCA by multiplying times (2.5/.2). The normalized number of voltage pulses from the upper and lower SCA buffers are summed and divided by 2 to obtain the background contribution from the spectrum of the middle SCA. This background contribution number is then subtracted from the number of voltage pulses stored in the middle SCA buffer.

In Option 2 the number of voltage pulses in the upper SCA buffers are normalized to the window width of the middle SCA. This background is then subtracted from the number of voltage pulses stored in the middle SCA buffer. It should be noted that Option 2 is a conservative approximation of the background contribution to the middle SCA. Option 3 allows the computer operator to input a fixed background to be subtracted from the middle SCA buffer.

Following background subtraction, the software adds the number of voltage pulse from the 15 middle SCA distributed buffers and compares that value with a threshold value entered by the computer operator. If the value exceeds the threshold, a signal is sent to the firmware to divert the soil in question when it reaches the diversion gate.

For the hot particle determination the software adds the number of voltage pulses from the middle SCA hot particle buffers in all combinations of three adjacent detectors. These values are compared with a preset threshold value entered by the computer operator. If the threshold value is exceeded in any set of three adjacent detectors a signal is sent to the firmware to divert the soil in question when it reaches the diversion gate.

The length of time the diversion gate remains open corresponds to the length of the counting interval in which the threshold was exceeded plus 2 seconds. Diversion signals for the distributed and hot particle operate independently.

Communications between the microprocessor and the main computer are by fiber optic link, to avoid spurious signals from ground loops and radar signals.

4.0 SOIL & CONTAMINANT CHARACTERISTICS

Soil within the radiological control area contains both natural and derived materials. No part of the surface is in original condition the materials having been either dredged from adjacent offshore areas or moved from other parts of the island. Natural materials include: shells and skeletons of marine organisms (corals, coralline algae, foraminifera, gastropods, pelecypods, and sponges), plant fragments (rootlets and woody material), and limestone (consisting of fine-grained calcium carbonate

with varying amounts of brown or gray humus). Derived materials include: imported basalt fragments (used as aggregate), asphalt, imported quartz and garnet sand (used as air abrasives), fragments of oxidized iron and copper and plutonium oxide particles.

4.1 Density

Density values determined before pilot plant studies indicated a high degree of uniformity for both dry and saturated materials (GA85). The density of dry bulk samples was between 1.5 and 1.7 gm/cm³ with an average density of 1.6 gm/cm³. The saturated bulk samples had a density value between 1.8 and 2.0 gm/cm³ with an average density of 1.9 gm/cm³.

The above measurements are compared with density values obtained for the -3/16" size material from the feed preparation plant which ranged between 1.1 and 1.2 gm/cm³. The lower density values represent the uncompacted density as a result of feed sizing. Density measurements obtained on saturated concentrate ranged between 1.8 and 1.9 gm/cm³.

4.2 Size Distribution

Several studies have been performed on the size distribution of Johnston Island soils. The Garvin study (Ga85) in 1985 collected 30 samples from the LE-2 area. Samples were obtained by removing the top 3 to 5 cm of soil with scoop. Sample size ranged from 61 to 133 grams. Each sample was oven dried to remove moisture and dry sieved using U.S. Standard Sieves (Nos. 5, 10, 18, 35, 60, 120, and 230) in a mechanical vibrator-shaker for 10 minutes. Results of this study are summarized in Table 1 and the bar Figure 5 illustrates the minimum, average and maximum weight percent observed in each size fraction. Samples for this study were obtained in an area where elevated levels of radioactivity were observed; however, samples were collected at random and no attempt was made to specifically collect hot particles in the samples. Radiation measurements of the size fractions did not indicate activity above background readings.

Results from Kochen study (K085) in 1985 indicated similar size distribution, however, the +4.0 mm size fraction contained greater weights. These data are summarized in Table 2 and bar Figure 6. The samples obtained for the Kochen study also contained particle contaminants in each sample allowing some insight into the size characteristics of the plutonium contaminant. The maximum activity observed in each size fraction of the 10 samples in the Kochen study is shown in Table 3 and plotted on Figure 7. Analysis of the hot particle in Sample 1 by Kochen indicated the contaminant was a 15 mg piece of magnetic metal. Separation of hot particles in these samples indicated from 77 to 100% of the activity in the larger size fractions was associated with a hot particle. Comparison of the activities observed by Kochen and the calculated content of plutonium oxide as a particle of equivalent diameter (See section 4.3) allows some insight into the impurity content of the particle. Observations during the current production run (see section 8.3)

indicated a high incidence of impurities in the larger contaminant pieces. Smaller contaminant particles were more apt to be of pure high density form. Many of the particles examined during this run were also magnetic indicating a stress alteration of 304 stainless steel as noted by others.

Soil size analysis was performed by Bramlitt, Hall and Wilde in 1988 (Br89) to determine the activity in the larger soil fractions. During that study, soil from a total of 38 locations was collected representing 386 Kg of soil. Seven samples were obtained from areas of Johnston Atoll which had been shown in a 1980 comprehensive radiological survey to have no TRU contamination above minimum detectable levels. The remaining samples were from within the RCA which encloses the former THOR missile launch complexes. Samples were collected from the top 30 cm of ground surface.

Soil sizing on the above samples was performed using standard dry sieve techniques. Sieve sizes utilized were: 5.08 cm, 3.81 cm, 2.54 cm, 1.91 cm, 1.27 cm, 1.11 cm, 0.95 cm, 0.79 cm, 0.64 cm, and 0.47 cm. Radiation measurements of the sized fractions were made with a 12.7 cm diameter X 1.6 mm thick NaI (TL) gamma scintillator with beryllium window. Radiation measurements were made on the entire contents of each tray as a single sample. No attempt was made to quantify the activity in the sample but rather to determine if the sample contained activity above minimum detectable levels. Samples with positive counts indicating the presence of TRU were defined to be those whose gross count rate equaled or exceeded the average background (as determined from the clean samples) plus 2.33 sigma. The results of these data are shown in Table 4. The number of samples in each size fractions which contained positive counts are shown in Figure 8. Utilizing these data an upper size fraction was identified which apparently contained no activity.

4.3 Plutonium Oxide Size Calculations

The theoretical specific activities which would be associated with spherical plutonium oxide particles of 11.5 gm/cc density are in Figure 9 for particle sizes of 1 to 400 microns. These calculations provide information on particle sizes when a particle was isolated in the laboratory or field. It also allows gross indication of particle impurities when particle sizes are known as in the case of the soil sizing studies.

5.0 PLANT SETUP & OPERATIONS

5.1 Plant Assembly & Test Programs

Components and equipment for the TRUclean plant arrived by barge at Johnston Island on October 6 and 7, 1988. The plant equipment was designed and sized to fit in 20 foot and 40 foot transport containers. A total of five, 40 foot flat racks, two 40 foot closed containers, three 20 foot flat racks and two 20 foot closed containers were required to transport equipment to Oakland, California and then by barge to the island.

Prior to equipment arriving on the island, footings were poured for the feed preparation section of the plant. A pocket of contamination was discovered in the area where the elevated storage silo and decontamination plant were to be located. Removal of this soil resulted in an excavation 20 ft. wide x 100 ft. long x 6 ft. deep which had to be backfilled with clean soil and compacted before footings could be poured.

Plant installation activities started on October 8, 1988 with placement of underground conduit lines for the feed preparation plant. The first piece of equipment was set in place on October 11 and the last on November 3. Electrical wiring and installation of detector shields were completed on November 12. The settling ponds required two, four foot deep trench excavations of 20 ft. x 110 ft. x 4 ft. Only minor contamination was observed during excavation and may have been a result of spreading and tracking by heavy equipment. The ponds were bedded with fine sand to avoid puncturing the liner and lined with 36-mil ultraviolet resistant dymaloy liners to reduce water losses.

Preoperational testing of plant equipment was initiated on November 11. This included:

1. Motor rotations and power measurements
2. Belt tensioning and tracking
3. Vibration transmission tests for component stress and wear
4. Measurement of conveyor belt speeds and range of speeds on conveyors with variable speed settings
5. Gravimetric separator stroke frequency settings

Equipment performed to specifications with the exception of the conveyor belt speed ranges on the four monitoring belts and the gravimetric separator feed conveyor. Replacement gearboxes and pulleys were supplied by the vendor and installed to reduce belt speeds to design specifications.

Hydraulic testing of the decontamination plant started on November 25 by introducing water to the system. During this test, gravimetric separator flow rates and stroke lengths were verified and water flows and pump capacities were measured to verify plant design parameters. During the hydraulic test, minor enhancements were identified which would improve plant control and performance. These included some piping changes, flowmeter additions and splash guards.

Delivery of the monitoring instrumentation for the sorter plant and decon plant fell substantially behind schedule due to development problems in the software and firmware. Because of the volume of data manipulations required in the microprocessor the

firmware had to be reprogrammed in machine language. One of the instrument packages arrived at Johnston Atoll on November 28, and was installed to verify instrument operation in the presence of radar signals. To perform this test, firmware and software programs were installed to allow operation of the counting system, but, did not provide manipulation of data in the microprocessor and computer. These test showed adequate design for protection against radar signals and verified instrument response to americium gamma photons. Operational testing was discontinued on December 7 pending delivery of the remaining firmware and software programs.

Operational testing of the firmware and software was resumed on December 27 in Las Vegas. System check-out identified several operational requirements which had not been met in the computer logic of the software and firmware. These had to be resolved to meet system specifications. Debugging, testing and modifications of software and firmware continued until January 27, 1989 when final acceptance tests were completed.

Cold testing was resumed at Johnston Atoll on February 11, 1989 with the introduction of "clean" soil in the plant, following installation of the remaining electronic systems and new software. Approximately 60 cubic yards of soil was used in the cold test program to establish initial operating parameters for the plant. Cold testing was completed on February 15.

5.2 Operational Demonstration

The first phase of the operational demonstration began on February 16, 1989 with the introduction of contaminated coral to the system. During this first phase (8 days), operations were dedicated to adjusting operating parameters and stabilization of the gravimetric separator. During the first phase of the operation, a total of 52 runs were completed utilizing different separator flow rates, separator frequencies, stroke lengths, feed rates, hutch aperture openings, artificial bed depths and water additions to coral entering the gravimetric separators. The effects of these parameter variations were measured against the radioactivity observed in the separator discharge and concentrate. The volume of concentrate was dependent on the establishment of a natural bed above the artificial bed in the gravimetric separator and was slowly reduced as the natural bed formed and other more favorable operating parameters were established. The large volumes of concentrate during the first few days of operations caused plugging problems with the discharge line of the cleaner supply pump.

Heavy rains on February 19 and 20, 1989 significantly increased the moisture content of the feed material. This resulted in material caking on the 3/16" vibrating screen and blinding the screen. Material which normally fell through the screen was routed through the hammermill and resulted in plugging of hammermill gratings. This problem was later alleviated by installing a 3/8 inch screen size with elongated openings. During the first phase of the demonstration a total of 182 cubic yards of material was processed through the system.

The second phase of the operational demonstration started on February 25 with simultaneous operation of all system equipment. During this phase 1,043 cubic yards of feed was processed. A detailed discussion of the material balance for is found in section 5.3. Five special tests were also performed which included: 1) oversized material, 2) rerun of diverted material, 3) narrow conveyor test, 4) rerun of concentrate material and 5) rerun of clean sorter material. These special test runs are described in detail in Sections 6.1., 6.2, 6.3, 6.4 and 6.5.

Table 5 is a summary of plant operating time and an analysis of routine and unscheduled plant shutdowns. Routine lubrication, startup and shutdown of the plant required from 1.0 to 1.5 hours per day. A shutdown was considered routine if it is expected to occur during extended operation of the plant. Shutdowns were not considered routine if they involved a special test or a problem which was resolved by equipment modification. The average plant throughput for the 8 days of routine operation was 94 yards per day.

5.3 Volume Reduction

Volume reduction is defined as the reduction of the volume of material which is classified as potentially contaminated, and it is expressed as the ratio of clean releasable soil volume to the total soil volume entering the plant. To evaluate the volume reduction attained by the plant, a material balance was generated for the 1043 yard portion of the operational demonstration when all plant components were operational. Figure 10 shows a material flow diagram of the TRUClean production system where volume measurements were made. Volume measurements at the plant feed, sorter feed and decon feed were obtained using the conveyor belt weigh scales. The volume of the oversize material was obtained by subtracting the sorter feed from the plant feed weigh scale measurements. The volume of sorter clean material and storage silo material were determined by calculating the time weighted positions of the sorter diversion gate for a given operating day. Concentrate volumes were obtained by actual measurement of volume generated. Pond sediments were measured upon completion of the operational demonstration and indicated a volume of about 66 yards had accumulated in the ponds. Prorating this to the 1,043 yard material balance would indicate 49 yards of sludge in the pond as compared with the calculated 34.3 yards in the material balance (Table 6). The volumes of decon clean and decon diverted soils from the system was determined by calculating the time weighted positions of the decon diversion gate.

Table 6 contains the daily volume measurements and calculate volumes at the specified points in the materials balance diagram. These volumes are summed and plotted in Figure 11. Further examination of the soil fractions included in each segment is required to fully evaluate the volume reduction capabilities of the system.

The material balance in Figure 11 indicated 9.2% (96.3 yards) of the material was ejected to the oversize pile. To evaluate the

clean/contaminated ratio of the oversize material, 7.5 cubic yards of oversized material was diverted directly to the hammermill and the diversion rate in the sorter plant observed. This test indicated 6.2% of the volume diverted to the contaminated stream and 93.8% to the clean pile.

The material balance in Figure 11 also shows 6.4% (67.04 yards) of the material was diverted by the radiation detectors on the monitoring belt. To evaluate the clean/contaminated portions of the diverted material, the diverted material was first recycled through the plant to determine if any of the plutonium was available for concentration. This test indicated 42.9% of the material would again be rejected as contaminated and 57.1% would pass as clean soil. A detailed discussion of this test is found in Section 6.2. The 43.1% of now twice diverted material was subjected to another test to evaluate the clean portion of soil remaining in the diverted material. This test involved sorting 7.5 cubic feet of the twice diverted material through a simulated 10 cm wide conveyor. This test indicated 88.3% of the material could be separated as clean and 11.7% of the material was rejected as contaminated. A detailed discussion of this test is found in Section 6.3.

Using the results of the test with oversize material, the recycle test and the 10 cm. wide conveyor test, the ultimate total volume reduction capability of the system can be estimated. These data appear in Table 7 and are illustrated in Figure 12.

The exploded pie sections in Figure 12 represent the contaminated streams from the system. The concentrate is 1.1% of the input feed as averaged over the 1043 yard run.

Implementation of a narrow conveyor to sort the diverted materials had the potential to further reduce the diverted stream to 0.71% of the original 1,043 cubic yard run. Based on the oversize test, the oversize contaminated fraction represents 0.57% of the original 1,043 cubic yard run. This contaminated fraction could be subjected to normal gravity separation and would most likely represent a smaller volume.

Pond sediments were analyzed by a contract Laboratory and found to have indicated low level of contamination. This volume of coral sludge was estimated at 3.3% of the total input volume to the system.

An evaluation of the volume reduction capabilities of the feed stream sorting system for the 1,043 cubic yard demonstration revealed that 56.8% of the coral soil could be sorted from the feed as clean (i.e., less than 500 Bq/Kg). The clean fractions which were sorted each day are shown on Figure 13.

5.4 Activity Reduction

The monitoring systems were designed to determine if plutonium activity in the coral was above or below the specified clean limits

and route the fractions to a clean or potentially contaminated stream. Although the monitoring system does not have provisions for accessing counting data some insight can be obtained into the activity reduction from the number and duration of the diversions in relation those to pilot plant studies.

During the 1986 pilot plant operations, a detailed evaluation of the number of particles and their concentration was performed for three runs. These data are presented in Table 8. Particle activities were calculated by observing detector count rates and correcting for detection efficiencies. The actual number of particles detected above background count rates were totaled for each specified run volume. The particle count per yard of feed and the activity per yard of feed are plotted on Figure 14 and 15 for the 1986 pilot plant feed and the plant discharge (or diverted). Since the soil processed during the operational demonstration was from the pilot plant stock pile, the diversion rates on the sorter plant should be relative to the pilot plant studies. More than one particle may be involved in a particular sorter diversion especially in the larger diversion times. To correct for this phenomenon the average number of diversions per yard of feed to the production system were corrected to the rate observed in the pilot plant studies when single particles could be detected at a slower belt speed. The diversion data and corrections are listed in Table 9. These data are plotted on Figure 16 for the decontamination plant feed and the particles diverted from the discharge.

Assessment of the total activity removed by the TRUClean production system per yard of feed material which was routed to the decontamination plant can be obtained by dividing activity collected in the concentrate by the plant feed cubic volume. These data are summarized in Table 10. For the production plant this value was 16.7 uCi/yard of feed which is compared to 12.7 uCi/cubic yard of feed on pilot plant. The diversions per yard of feed and the concentrate activity in uCi/cubic yard of feed are plotted in Figure 17.

5.5 Concentrate Rerun Test

Concentrate from the cleaner gravimetric separator was dewatered and collected in a 40 inch diameter by 40 inch high fiberboard container with a poly liner. Assay of the concentrate was performed utilizing a 12.7 cm diameter x 1.6 mm thick NaI(TL) detector suspended 66 inches above the bottom of the container.

The NaI detector was coupled to a single channel analyzer counting system. As the concentrate accumulated in the container, counts were taken on the incremental layers. These counts were evaluated by computer programs to establish the total activity in the container. The activity assayed in each container is presented in Table 11 and plotted in Figure 18. As can be seen from the graph, a steady increase is observed in concentrate activity. This trend reflects the process adjustments which were occurring during the operational demonstration to optimize system performance.

Table 12 contains the daily feed, concentrate and diversion volumes. The corresponding decrease volume of concentrate per yard of feed is also observed in Figure 19.

The concentration of radioactive material in the concentrate will be a function of activity in the feed and system operating parameters. It is probable that further adjustments in operating parameters will increase concentrations closer to the 2 nCi/gm activity level. Although this trend was apparent during the operational demonstration, time did not allow full exploration of the upper limit of this parameter.

5.6 Diverted Soil

Contaminated particles which had a low density, or particles which were attached to a piece of coral, eluded the gravimetric separator and were removed from the clean stream by the diversion system. The volume of soil diverted by the diversion system is shown in Table 12. This volume is graphically shown in Figure 20 as a function of feed volume to the decontamination portion of the plant for the 1,043 yard run. Although the volume of diverted soil was somewhat higher than expected, examination of pilot plant operations and methods of removing diverted material in the pilot plant operations show that the higher volume fraction could be explained.

Table 13 is a material's balance for pilot plant runs 269 through 276. An average diversion rate of 14.7% of the feed volume was observed for these runs. This value is compared with the 1,043 cubic yards for the operational demonstration runs which had an average diversion rate of 18.9% . The method of removing diverted material from the pilot plant involved manually locating the hot particle with a FIDLER gamma survey instrument and removing the area with an 8 inch wide scraper. This resulted in a very small volume of soil per diversion as compared with the automatic diversion system on the TRUClean production system which diverted an entire belt width of material.

6.0 SPECIAL TEST RUNS

6.1 Oversize Material

Sizing studies performed in April, 1988 on 380 Kg of soil indicated contamination was not present in the size fractions above 2.54 cm. Based on these studies, a screening level was established which would divert soil greater than 2.54 cm before it entered the hammermill. This material must be processed since it could contain activity embedded in the coral. To verify the contamination content in the plus 2.54 cm fraction, a total of 7.5 cubic yards of the 96.3 cubic yards of oversize material was processed through the plant and the number of diversions observed. Results of this test are shown in Table 14 and Figure 21. This test indicated an average of 6.2% of the volume contained radioactivity above 500 Bq/Kg or contained a 5 KBq particle.

The oversize material test was run following extended operations with contaminated feed and the system was not cleaned prior to the tests. Residual radioactive particles may have remained in the system and accounted for some of the diversions, rather than soil consolidated around activity. A much larger test volume is needed in order to obtain a data base with a high degree of confidence.

6.2 Divert Rerun Test

Examination of 19 diverted particles indicated about 50% of the particles which evaded the gravimetric separator were attached to large pieces of coral. The remaining particles were hollow spheres, or low density materials. One hundred thirty cubic yards of diverted material was rerun through the system, to evaluate the extent to which additional cleanup might occur. These attached particles could be removed by additional handling, screen induced vibrations, and action of the gravimetric separator. The data from this test is shown in Table 15 and illustrated on Figure 22. During this test, activity was observed in the concentrate, however, some mixing of rerun materials with other soils occurred during stockpiling, drying and handling.

A similar test was performed in 1986 using the pilot plant and 8.0 cubic yards of material which was diverted during pilot plant test runs. This data is shown in Table 16 and indicated an average of 13.6% of the volume required diversion during the rerun test. The large difference in results from the pilot plant (13.6%) and the production system (57%) is thought to be the result of the manual method used in removing activity from the pilot belt and the automated system used in the production belts.

6.3 Narrow Conveyor Test

The volume of soil associated with the diverted material represents a significant volume but contained only a few particles of plutonium per cubic foot. Isolation and examination of particles diverted in the rerun test again indicated either low density contaminated material or particles attached to larger coral pieces. To evaluate further volume reduction capabilities available on this stream a 10 cm wide conveyor belt was simulated by blocking off all but a 10 cm wide opening on the center of the 84 cm wide monitoring belt. A 6.5 cubic feet sample of diverted materials was placed on the monitoring belt behind the leveling gate to form a 10 cm wide stream of soil. The sorting capabilities were then operated normally.

Results of this test are shown in Table 17 and illustrated in Figure 23. Based on this test, the narrow stream could be sorted into a clean section representing 88.4% of the volume and a contaminated stream representing 11.6% of the volume. The material diverted to the contaminated stream was placed in a concentrate container and assayed. This assay indicated a plutonium concentration of 1.23 nCi/gm. Although this test involved a small

volume of soil, the feasibility of the concept was demonstrated to be effective for further volume reductions. Because of time restraints, only one test was performed on the diverted stream. A more precise evaluation of the potential volume reduction will require a larger data base. Examination of the diverted stream from this test with a FIDLER survey instrument indicated a multitude of particles; therefore, the possibility of only a few very hot particles was discounted.

6.4 Concentrate Rerun Tests

On March 14 the concentrate collected in the first eight concentrate containers was routed to the storage silo for a test rerun on the concentrate material. These containers represented the concentrate collected during the first seven days of system operations and contained the lowest concentrations of activity. Since this material had previously been concentrated and contained material with higher density, it represented a drastic change in feed characteristics. Considerable time was required for readjustment of operating parameters. The average activity of the eight containers of concentrate was 0.20 nCi/gm. Following reprocessing the concentration of activity was increased to 1.06 nCi/gm. Data from this test are shown in Table 18. Since the concentration of activity continued to increase during the operational demonstration, rerunning or recycling concentrate may result in concentrations exceeding 2.0 nCi/gm.

6.5 Clean Monitoring Test

During the operational demonstration a considerable number of changes and adjustments were required to optimize the system performance. In an attempt to evaluate the quantity of particles which could have circumvented the system during adjustments, 38.4 cubic yards of suspect material from the sorter clean pile was rerun through the sorter monitoring system. This test resulted in 702 diversions or 18% of the soil volume. Random mixing of particles will locate them at different soil depths and probably accounts for the diversions.

The monitoring system is set to divert particles located at a depth of 1.9 cm which contain 5 K Bq of activity. If 10 particles containing 4.9 K Bq pass through the monitor system at this depth, when they are randomly mixed and sent through the system again we would expect 9 of the 10 particles to be diverted. Because of the higher detection efficiency for a particle located at a 1 cm depth, the system would reject a 2.3 K Bq particle assuming it was a 5 K Bq particle located at the 1.9 cm depth. If 10 particles containing 2.2 K Bq are located at a depth of 1 cm and pass through the system, we would expect 5 of the 10 to be diverted when they are randomly mixed and sent through the system again. If the soil is further divided into 10 incremental depth layers, we would expect about 45 out of 100 particles to be diverted when we rerun the material.

Based on the criteria of allowing 1 particle with activity of 5 K Bq per 0.01 cubic meters, the 38.4 cubic yards of soil could have contained 2940 particles with a 45% diversion rate for rerunning the material, 1,321 diversions would have been expected.

7.0 PROCESS MONITORING SYSTEM

7.1 Efficiency Calculations

During conceptual design, theoretical efficiency computations were performed to determine the count rates which would be obtained for various detector geometries. Based on these computations, the 15 detector array was selected as the most cost effective to obtain the required sensitivity. For the purpose of the calculations, efficiency is defined as the percent of 60 Kev americium gamma photons which are detected by the system relative to the total photons emitted by the source.

The following assumptions were used in the calculations.

1. The density of dry coral was 1.75 gm/cm³ and water saturated coral was 1.9 gm/cm³.
2. All gamma photons striking the detector were counted (i.e., no absorption in detector face).
3. No photons were detected through the sides of the detectors.
4. The distance from the radioactive particle to the detector face was greater than the average diameter of the particle.
5. Self absorption of gamma photons in the particle is negligible. Although this assumption is not true for large particles it is believed to be a close approximation when considering small particles with activity of around 5 K Bq.

The model used in the calculations is shown in Figure 24. A point source (S) was located at a distance (X) from the edge of the belt and at a distance (Y) from the detector bank centerline. Each detector was divided into 100 incremental sections representing a one square cm area (D1, D2, D3). The gamma photons from the source were projected on to each incremental section of the detector, and attenuation along the slant distance through the coral was calculated. The resulting gamma photons which strike each detector increment were summed to obtain the detector count rate. The detectors efficiency was then calculated based on the number of gamma photons counted verses the total photons emitted from the source. One hundred and sixty eight calculations were performed for 10 source positions on each side of the detector bank centerline (Y

plane), 4 positions in the X plane, and 2 positions in the Z plane (top of soil and bottom of soil). Results of the model calculations are shown in Tables 19 through 26 and graphically represented in Figures 25 through 32.

The monitoring system was designed to sum the counts from three adjacent detectors when examining the soil for a hot particle. The calculated count rate for the three detectors model was summed in Tables 19 through 26 for each source position considered in the calculation. Figures 33 and 34 indicates the theoretical count rate for the three detector array as a particle moves up the belt under the detector array in four different source positions in the X plane and located at the bottom and top of the soil layer.

Figure 35 provides a profile of detector count rate at the detector bank centerline across the belt in the X direction. The three detector groups are repeated across the belt and will have the same count rates as those calculated in the model. This graph included for comparison with actual system calibration developed in the next section.

7.2 System Calibration

Verification of efficiency calculations and system calibration was performed using two hot particles retrieved from the feed stream. The activity of these particles was determined using the Davidson multichannel analyzer which had been calibrated with a National Bureau of Standards Source. The National Bureau of Standards traceable point source was positioned in a reproducible location above the 4" x 4" crystal. After counting the standard and determining the systems counting efficiency, the two hot particles we counted in the same location and their activities calculated. The particles were attached to the bottom of a flat aluminum tray (36.6 cm by 77.5 cm and 1.91 cm deep) and 1.91 cm of clean soil placed in the tray. The tray was then placed under the detectors and counted using the constant background subtract method and the upper and lower SCA method. The data from this calibration are shown in Table 26 and compared to the calculated efficiencies. The source locations of the sources corresponds to the equivalent location where calculated efficiencies were made. The measured efficiencies were higher than the calculated efficiencies. This was probably due to the use of higher coral density (1.75 gm/cm³) in the theoretical calculations.

Actual measurements of detector count rates at the top of soil and at a depth of 1.91 cm in 3/16 inch sized coral provided the necessary data to calculate the actual attenuation coefficient. Based on the empirically determined attenuation coefficient, the detector count rate was again calculated for the 1.91 cm depth. A plot of the recalculated count rate profile for a 5000 Bq particle across the belt in the X direction is shown in Figure 36. Comparing these results with Figure 35 indicates a higher count rate at the 1.91 cm depth utilizing the empirically determined attenuation coefficient.

7.3 Diversion System

The diverter systems of both the sorter plant and the decon plant were designed to divert soil from the clean stream in the event radioactive material in quantities greater than design limits were present on the conveyor belt.

Two sets of criteria were established for the Johnston Island program. One was based on discrete 5000 Bq hot particles in a finite volume of soil of 0.01 cubic meter or smaller. The second was based on a 500 Bq/Kg distributed mixture of radioactivity in the soil to be measured in increment volumes of no greater than 0.1 cubic meters.

To assure these diversion limits were met, a bank of sodium iodide radiation detectors scanned the "clean" soil on a conveyor belt which passed beneath the detectors. The soil was leveled to a layer 1.91 cm thick and the belt speed was adjusted so that each increment of soil resided under the detector bank for two seconds.

For discrete particle detection, the electronic data processing firmware of the detector systems totaled the counts from each set of three adjacent detectors over the two second count interval. If a preset limit from the three detectors was reached, the soil diversion system was activated.

For uniformly dispersed radioactivity, counts from all of the 15 detectors were accumulated for a 10 second interval. The 10 second total count was then compared to a second preset limit. If the preset limit for uniform contamination was reached, a 10 second soil diversion program was activated.

A number of parameters must be in correct adjustment to assure the proper operation of the diverter systems. The more important of these are:

- 1) The time delay between the generation of a divert signal and the time the radioactivity reaches the drop off point of the conveyor belt.
- 2) The conveyor belt speed.
- 3) The time the diverter remains open.
- 4) The behavior of the particle on the conveyor belt.
- 5) Counting time intervals for accumulating counts used in divert signal generation.

To assure that the mechanical aspects of diverter system were in proper adjustment, a series of tests were performed by sending a variety of radioactive sources through the diverter system. The results of these tests are listed in Table 28. In Table 28 the divert signal column is the time set in the computer to delay the

diversion following detection. The duration of the diversion column is the time the gate was actually open. The time to eject column is the time it took the particle to arrive for diversion following gate opening. From these data it appears that the 29 second divert delay time would be appropriate for the current belt speed.

8.0 PROCESS STREAM RADIOACTIVITY

8.1 Soil Process Streams

Several process streams are developed during the operation of the Production plant. This section briefly describes each of these streams and the monitoring that was done to assure that the radioactive material remained within design objectives. These streams are:

1. The feed stream from stockpiled island coral.
2. The sorter plant "clean" stream.
3. The decon plant "clean" stream.
4. The decon plant concentrate stream.
5. The decon plant diverter stream.
6. The decon plant sludge stream.

The feed stream is introduced into the system via front-end loader. This feed stream contains a variety of radioactive debris and coral. Radioactive particles containing more than 40 uCi of plutonium are fairly common in the feed material as are a wide variety of smaller radioactive particles.

The sorter plant "clean" stream is soil which has passed through the diverter system on the sorter plant and contains radioactive particles below the established "limits." This soil should meet design objectives.

The material which has been determined to be contaminated proceeds to the TRUclean decontamination plant. All material entering the decon plant is processed through the TRUclean gravimetric separator and separated into three streams; the concentrate, the gravimetric separator discharge, and sludge. The concentrate stream terminates in the concentrate receiver container. The gravimetric separator discharge stream, however, continues on to the decon plant monitoring system where it is further split into two process streams - the diverted stream and the decon plant "clean" stream. The sludge proceeds to the settling ponds.

8.2 Process Stream Radiation Assay System

To assure confidence that the radioactive material contained in the various clean streams were within design specifications and to allow investigation of activity movement in the plant, eight programs were designed to monitor the various streams. These assay programs are:

1. Flat tray assay system.
2. Sample box system.
3. Radiochemical assay system.
4. Clean pile FIDLER survey system.
5. Large area Germanium survey system.
6. Soil fraction sizing system.
7. Particle isolation system.
8. Concentrate assay system.

8.2.1 Flat Tray Assay System

This system was designed to take advantage of the counting system provided by the banks of thin crystal detector arrays used in the plant's detection systems. A flat aluminum tray measuring 35.6 cm by 77.5 cm and 1.91 cm deep was fabricated to provide a soil sample holder. Soil samples were collected from several random locations around the clean soil piles. The soil-filled tray was then placed underneath one of the 15 detector arrays and counted both in the background count mode and the calibration count mode. The background count mode on the monitoring system is normally used to determine the background counts on clean soil placed under the detectors. This mode also provided a means to count other samples and obtain sample plus background counts. The calibration count mode on the monitoring system is normally used to count calibration standards under the detector array to verify system response. This mode, also was used to count other samples and provided net sample counts with background subtracted by one of the three background subtraction modes discussed earlier. The counting time for these two modes could be adjusted (the conveyor belts were not moving) for any counting period up to 30 minutes. Using the detector array to monitor a tray provided information regarding the total activity in the tray as well as the location and distribution of the radioactivity.

Several techniques were used to relate counts from the tray to activity in the tray. Table 29 lists the assay data obtained from daily counting of flat trays filled with soil from the sorter clean and the decon clean soils. The first column is the date of sample, sample code number and the origin of the sample. The second column indicates the counting method utilized, counting time and net count calculations for background subtraction. For example; B 10 indicates background count mode which gives gross count rate in the ROI for a 10 minute count; C 10 indicates calibration count mode and gives the net counts in the ROI for a 10 minute count utilizing the upper and lower SCA to spectrum strip background; H indicates the background ROI count obtained on a flat tray filled with clean soil and counted in the background count mode for 2,520 seconds;

B-H is the net counts in the ROI following background (H) subtraction.

The columns with heading numbers 1 through 15 gives the counting data for detectors 1 through 15. The data from detectors 1 through 15 is summed and appears in the next to last column of the table. The last column is the assayed activity of the flat tray. The flat tray samples represented a volume of about 0.005 cubic meters.

Examination of the individual detector data in Table 29 indicates elevated readings where "hot" particles are located. To determine if the counting system and diverter gate were operating properly and diverting particles above 5000 Bq, radioactive particles were removed from those flat trays where counts indicated a particle might be present. After removing the particle from the flat tray they were counted to determine activity. The results of this study are shown in Table 30. All particles retrieved in the study were below the 5000 Bq limit except the 17,172 Bq particle found on March 15. It was postulated this particle could have been relocated from its original inventory point on the conveyor belt by the side skirt friction hence avoided diversion.

The elevated count rate observed from the three adjacent detectors directly above the "hot" particle in the tray was totaled to evaluate the detector efficiencies. The efficiencies observed were within the range calculated in Section 7.1 and measured during system calibration considering the particles were located at random depths through out the soil.

8.2.2 Sample Box System

A small portion of each daily flat tray of coral was retained in a 4 inch square by 3 inch deep sample box for radiochemical analysis. These sample boxes were also counted on a thin crystal NaI detector coupled to a multichannel analyzer. The thin crystal was enclosed in a box with a removable lid and shielded with 1/4 inch of lead. Sample boxes were positioned directly on the crystal face.

Table 31 is a summary of the results of activities measured in the sample boxes. Of particular interest is the sample on February 18 which indicated 2128 Bq/Kg. This result is compared to the flat tray count of 450 Bq/Kg from which the sample was obtained. The difference in results indicates caution must be exercised when extrapolating small volume sample analysis to a larger volume.

8.2.3 Radiochemical Assay System

As a final check for radioactivity in random flat tray samples, a portion of the soil was removed from the top of a number of sample boxes from daily runs. Samples were sealed in plastic petri dishes and returned to a commercial laboratory for TRU content analysis. In some cases split samples were also sent to two independent laboratories. Results from radiochemical analyses are shown in Table 32. The average of all radiochemical analysis indicated a TRU concentration of 411 BQ/Kg which is in close agreement with the 381 BQ/Kg average value obtained from tray counts.

8.2.4 FIDLER Hand Survey of Process "Clean" Piles

In order to supplement the random sampling accomplished by the tray assay system, each "clean" pile of soil from both the sorter plant and the decon plant were surveyed using the hand held model ESP 2 Eberline FIDLER detector. The FIDLER detector has a thin sodium iodide detector and single channel analyzer capability.

Initially only the portion of the "clean" piles that could be easily reached from the ground was surveyed. As the search for hot particles that may have escaped the TRUclean system intensified, the survey area was shifted to the entire "clean" pile. Surveys of each "clean" pile was conducted between two and four times per day.

8.2.5 Large Area Germanium Detector Survey

To provide a much larger sample for a random independent assay, a suspended germanium detector was used. The HpGe detector was suspended above a 10 foot diameter hexagonal area on a concrete slab.

This system consists of a high purity germanium detector connected to a Davidson portable multichannel analyzer.

These assay data were collected by the DNA representative as an independent check on the other assay systems. Two types of measurements were made. One initial measurement was performed and then a second measurement was made after "hot particles", which were located via "FIDLER" Survey had been removed.

The initial count provided data on the number of "hot particles" reaching the "clean piles." The second count gave data on the condition of the bulk soil. Data from the results of these HpGe measurements are reported in Table 33.

8.2.6 Soil Sizing System

Soil particle size and radioactivity of each soil fraction was determined for each stream, except the sludge stream, by dry sieving. After the sample had been segregated into its various particle size fractions, each fraction was counted on the thin crystal sodium iodide detection system. These counts give a relative indication of the size fraction containing the largest amount of radioactivity. Data from the sieving measurement are reported in Table 34 through 46.

Only one particle was found in the three samples obtained from the plant feed. This is consistent with previous observations. The three samples obtained from the clean piles had activity levels below the 500 Bq/Kg limit, however, the sample taken on 3/10/89 did have one particle in the 100 mesh screen, but it is below the allowable 5K Bq limit. Two of the three samples obtained from the diverted material contained a radioactive particle confirming the material should have been diverted. Two concentrate samples contained significant activity in several size fractions. These particle sizes are in the range which the gravimetric separator most efficiently concentrate.

8.2.7 Particle Isolation System

Each radioactive particle with activity greater than 5000 Bq, found in any stream other than the concentrate stream, was considered to be an event outside the system design criteria. As such it was necessary to isolate the particle from the process stream to determine the physical characteristic which allowed it to defeat the removal systems.

Particles were collected from all process streams including the concentrate stream by isolating the radioactive particle from all other soil particles. This was accomplished by first locating and removing soil from the general area of the particle using the sensitive FIDLER detector. The soil was divided into two piles and the pile containing the particle identified. The pile containing the particle was again divided into two and so on until the particle became visible so it could be manually isolated.

8.2.8 FIDLER Measurement of Radioactivity Content of Concentrate Stream

To determine the radioactive content of the concentrate, counts were taken with a FIDLER suspended above the concentrate container. The concentrate was leveled in the box prior to each FIDLER count and the count recorded.

Data from this assay system was used by DNA to evaluate the radioactive content of the concentrate container. Data from the concentrate FIDLER measurements are presented in Table 47. The radioactive concentration of the concentrate boxes ranged from 0.08 to 1.6 nCi/gm. Concentrate box 24 contained the highest amount of activity at 1,288 uCi.

8.3 Particle Studies

Several studies were made on particles isolated in each of the process streams to determine their physical characteristics.

8.3.1 Raw Feed Stream to Sorter Plant

During the initial start-up, a survey of stock piled soil was made to locate "hot" feed particles. Table 48 describes the four particles separated.

8.3.2 Concentrate Sample Particles

The particles examined from the concentrate stream are particles which were removed by the decontamination process. A few of these particles was studied to evaluate their characteristics. Data from this study is shown in Table 49.

8.3.3 Diversion Stream Particles

Particles are in this stream because of proper action of the diverter system, however they represent, in a sense, a failure of the gravimetric separator to remove them. The characteristics of these particles were studied in an effort to determine what allowed them to pass through the gravimetric separator.

It was clear that all of the particles were either low-density, had a low density configuration such as a hollow sphere, or were firmly attached to a larger fragment of wet coral. The term "floater" was coined to describe these particles or the particle carriers. A description and some of the characteristics of these particles are presented in Table 50.

In one test run several yards of material was taken from the diversion pile and rerun through the gravimetric separator. The material had been dried and it was noted that radioactive particles adhering to coral fragments often fell off after drying. Particles that were not removed in the gravimetric separator a second time and were diverted are referred to as twice diverted. Data on these particles is shown in Table 51.

8.3.4 "Clean" Stream From Decon Plant

Daily quality assurance surveys with the FIDLER instrument of the decon plant "clean" stream piles began to locate a few individual particles which exceeded the 5000 Bq TRU design criteria. As the feed stream to the plant became increasingly contaminated, the number of individual particles on the "clean" piles increased. As more were detected, the frequency and extent of the surveys were increased.

Many of the recovered particles were isolated to determine the characteristics which may have allowed them to defeat both the gravity separator system and the radiation detection diverter system. Table 53 lists the particles separated from the decon clean stream. Test samples were made from separated particles by placing them in small plastic boxes and painting them fluorescent pink. These "tagged" particles were sent through the diverter system to locate system conditions which would permit them to reach the "clean" pile.

8.3.5 "Clean" Stream From Sorter Plant

The sorter plant "clean" pile in the decon plant was surveyed on a daily basis with the FIDLER. Considerably more effort was spent sampling this stream since only the diverter system had an opportunity to remove "above limit" particles from the stream. Consequently, significantly more particles were isolated in attempts to locate processes by which they eluded the diversion system. Characteristics of these particles are presented in Table 53.

8.3.6 Conclusions From Particle Studies

Studies on the particles eluding the diversion system indicated they had sufficient activity (>5000 Bq) to allow detection by the monitoring system and should have been diverted. The mechanisms by which these particles avoided diversion were identified as one of three probable causes.

1. Diversion time - the time from particle detection to diversion was too long hence the particle passed the diversion gate before it opened.
2. Belt wiper - particles adhered to the belt wiper and fell into the clean stream following the diversion.
3. Belt side skirting - particles located next to the side skirting on the belt

could be relocated from their original inventory point and arrive at the diversion point following gate diversion.

Each of these problems were addressed and proper settings made or temporary changes made to reduce the number of particles eluding diversion. Permanent changes to the system are recommended at the end of this report.

9.0 Statistical Analysis

The minimum detectable activity (MDA) was determined to assure that it was adequately below the design limits of the system. Samples with count rates equal to or greater than the MDA will be detected by the counting system.

In the case of a single detector (first counting the ambient background and then counting a source and background together), the uncertainty in the count is expressed as the square root of the sum of the squares of the uncertainties in each count.

Thus for a count to be accepted as positive, the difference between the sample counts must be greater than the uncertainty. This is expressed mathematically as:

A = the count rate from Am-241

Rs = the sample count rate which includes
the background and sample count rates

Rb = the separately measured background count rate

ts = sample count time

tb = background count time

the standard deviation of Rs is $\sqrt{\frac{Rs}{ts}}$

likewise the standard deviation of Rb is $\sqrt{\frac{Rb}{tb}}$

Therefore:

$$A = (Rs - Rb)^{\frac{1}{2}} \sqrt{\frac{Rs}{ts} + \frac{Rb}{tb}}$$

and for A to be real the count must be sufficient such that the following expression is true

$$R_s \geq R_b + (2) (1.65)$$

$$\sqrt{\frac{R_s}{t_s} + \frac{R_b}{t_b}}$$

To obtain a 95% confidence level the minimum detectable count rate (MDCR) is:

$$\text{MDCR} = 3.30$$

$$\sqrt{\frac{R_s}{t_s} + \frac{R_b}{t_b}}$$

Thus for various count rates R_s and R_b and for various count times t_s and t_b the minimum detectable count rate can be calculated. This approach was used to evaluate the data obtained from the diversion system counting system and determine the MDA for various counting situations analyzed in this section.

The system design flexibility permits the use of several different statistical methods. In one situation the entire array of 15 detectors is considered as a single detector. In another, each of the 15 detectors may be evaluated in groups of three detectors.

9.1 Operating Modes

The detector system was designed to operate in two simultaneous modes. One mode accumulates counts from all 15 detectors for a preset 10 second time interval to detect distributed contamination. The second mode accumulates the counts from each set of 3 adjacent detectors for a 2 second time interval to detect hot particles.

9.2 Clean Soil Background

Table 54 shows the background count rate obtained with three samples of clean soil placed under the B (lagoon side) belt detector system of the decon plant. An average count rate and the standard deviation was obtained for each of the 15 detectors and the entire The clean soil background results were 30.28 ± 0.59 cps (standard deviation) respectively.

All other tray sample counts were also made on the B set of detectors of the decon plant with the tray always placed against the belt side next to the A conveyor. The value of B 30, B 10 and B 2 listed on the table indicates counts of 30 minutes, 10 minutes, and 2 minutes on the B system respectively.

9.3 Evaluation of Minimum Detectable Count Rate

Table 55 illustrates examples of various background subtract methods applied to actual tray samples.

In the final line of the upper portion of the Table 28 the static background count H for each detector is shown. This value subtracted from the counts for each particular detector yields the

detector counts and is used to compute detector standard deviations.

The MDCRs were calculated utilizing the previously discussed formula. In one case the sample was counted for 10 minutes and the background for 10 minutes. The next row shows a two minute sample count and 10 minute background count.

The next two rows are data from six mock-up tests of the conveyor belt dynamics in which the tray represents soil on the belt. The 10 second count time for uniform contamination on the belt is the actual count time used. The "clean soil" background counting time (tb) was reported by 600 seconds which is the maximum counting time permitted by the system.

The dynamic background subtract method built into the detector system utilizes both a sample count time and background count time of 10 seconds. Under these conditions the MDCR increases significantly. However, the MDCR for the tray is 10.16 counts per second under the dynamic system background count indicating good counting statistics even in the dynamic mode.

The other two examples on Table 55 illustrate data for samples from March 9 from the decon plant and from the sorter plant. Detector 2 on the sorter plant show "hot" particle count rate of 32 cps by the dynamic background subtract method using both the upper and lower SCA's. The symbol, C4, on the table indicates a tray count using the dynamic background subtract mode C for 4 minutes.

The particle was removed and isolated and found to contain 11.8 nCi of Am-241.

9.4 Statistical Analysis in Groups of Three

One of the more interesting aspects of the TRUclean detection system is its ability to accept, store and sum counts from each set of three adjacent detectors. After summing the counts for a preset counting time of two seconds it compares this compiled data value to a preset limit and, if exceeded, will initiate a diversion.

Table 56 is the data from the 15 detectors in groups of three and shows the calculated MDCR for two situations. One arrangement used a fixed static background count (H) and a second used the dynamic background system with a two second count time. For these dynamic background methods the soil and the background are each counted for two seconds. In many cases the individual detector MDCR exceed the actual count rate - yet the sum of the three detectors gives the positive reportable value. Hot particles, like those under detector two and nine on the sorter plant, resulted in a 33 count per second value by the dynamic background subtract mode and a minimum detectable count of 16.32 cps. (The 11.8 uCi Am-241 particle responsible for the 33 cps count is well within the specified decontamination criteria of 5,000 Bq of TRU).

10.0 HEALTH PHYSICS ASPECTS

10.1 Air Sample Data

Plant equipment has been designed to minimize and contain dust to the extent possible. The potential dust generating areas of the plant have also been located downwind to eliminate dispersion of potentially radioactivity dust to clean plant areas. All personnel working in the area of the feed preparation plant were required to wear respiratory protection as a safeguard against any airborne respirable activity.

During plant operations air samples were collected in five general areas. Samples were collected with high volume air samplers during plant operations from areas likely to have entrained activity. Samples were obtained on the front end loader with a low volume sampler located next to the equipment operator. Filter papers were counted for gross alpha activity to determine the air concentrations and the results are reported in Table 57. Air concentrations were generally below 17 fCi/cuM with the exception of three samples. One sample on the front end loader was 147 fCi/cuM which was probably due to a small particle from soil loading operations into the grizzly. Another sample directly in the down wind plume from the grizzly dumping station indicated 394 fCi/cuM, and one sample from the sorter plant, located next to the hammermill was 236 fCi/cuM.

In all cases the air concentrations were considerably below the 40,000 fCi/M3 maximum permissible concentration. Air samples were sent to a outside laboratory for verification analysis.

10.2 Smearable Contamination

Routine removable contamination swipes were taken in work areas to verify containment of radioactive contamination. All routine swipes showed non-detectable alpha activity.

Plutonium particle studies were performed inside a steel pan for contamination control. No contamination was detected from this operation except on the filter papers which were in direct contact with the plutonium oxide particle. This contamination was minor in nature and did not present a contamination control problem.

11.0 SUMMARY AND CONCLUSIONS

The performance test demonstrated that the Johnston Atoll soil cleanup plant has the capability to decontaminate soil at relatively large rates. After the plant was fully checked-out and operating parameters were optimized, it averaged a daily ate of 70 cubic yards and achieved an overall volume reduction of 80 percent. Radiochemical analyses of grab samples generally indicated cleanup guidelines were met. Although design objectives were not fully met, probable causes for failure were identified, and remedies can be incorporated.

The initial material balance indicted a volume reduction of 80 percent was achieved by the plant. Processing the oversize material through the plant would increase the volume reduction approximately to 89 per cent. The volume of diverted material represented a larger volume than projected from pilot plant data. This material consisted of particles attached to coral or low density materials and was not available for concentration by the gravimetric separator. Review of the pilot plant operations and method of removing the diverted material is one of the likely reasons for the smaller volume in the pilot plant. Based on the test of a narrow conveyor sorting system, this diverted volume could be substantially reduced and the design objective of 95 per cent volume reduction achieved.

The pond sludge contains up to 3,700 Bq/Kg of activity which exceeds the 500 Bq/Kg clean limit. Decontamination of the sludge could further increase volume reduction to around 98 per cent.

During the last 17 days of the demonstration a total of 1,207 cubic yards of soil were processed through the plant. Several test were performed during this time period which were not considered as routine operation. Wet soil also plugged the screen and crusher during this time period and a larger screen was installed to prevent this problem. If these non routine tasks are excluded an average process rate of 94 cubic yards per day would have been achieved.

Residual radioactivity in the clean soil was below the 500 Bq/Kg limit. The average activity of all radiochemical data was 411 Bq/Kg. Samples of clean soil counted by the germanium detector averaged 387 Bq/Kg and the average activity of the daily flat tray counts was 382 Bq/Kg.

12.0 RECOMMENDATIONS

During the plant operational demonstrations some enhancements were identified which would further reduce contaminated soil volumes or improve the plants reliability and performance. These recommendations are discussed below.

1. A conveyor belt should be added to remove material diverted from by the diverter gates at the decontamination plant monitoring belts. The diverted material is presently accumulating below the diverter gate and requires periodic removal with a front end loader. The addition of the conveyor will allow easier access to the stockpile and avoid possible equipment damage.
2. A narrow, four inch wide, conveyor and monitoring system plus diverter gate should be constructed to reduce volume of diverted material (see section 5.6).
3. Because some hot particles apparently escaped diversion by adhering to the belt wipers, a more effective wiper system assuring belt clean off should be devised.

4. The side skirting on the monitoring belts caused friction on the material traveling up the belt and provides an opportunity for a hot particle to be relocated from its original inventory point and arrive at the diversion point after the gate diversion. A temporary modification was made to limit the width of material on the belt to one inch inside the belt side skirting which was successful in alleviating this problem. A permanent set of guides should be installed to keep material away from the side skirting.
5. Occasional adjustments were required on the conveyor belt speed controllers which are presently mounted inside the motor control centers (MCC). These adjustments require shutdown of equipment to access the controllers. The controllers should be relocated outside the MCC in their own cabinet.
6. Monitoring conveyor belt speeds are critical to assure an inventoried hot particle arrives at the diversion gate at the proper time. Addition of a belt speed read-out system would be very desirable and increase system reliability and control.
7. A mechanism for weighing the concentrate container should be added to allow measurement of concentrate weight as the container is filled. This would improve the precision of the concentrate assay.
8. Excessive water was present in the concentrate container and required manual removal as the container was filled. Additions or improvements in dewatering techniques should be made.
9. Slippage of material traveling under the leveling gate on the decontamination plant monitoring belts resulted in occasional restrictions in material flow. A temporary wedge was installed ahead of the leveling gate to minimize this problem. A permanent leveling device should be constructed and installed on these two belts.
10. The slurry pump which receives the concentrate from the main gravimetric separators experienced occasional blockage, especially during upset conditions. A larger pump or the addition of a second pump for the other separator is recommended.
11. Further analysis of the contaminant characteristics in the pond sludge should be performed and decontamination techniques or disposal methods resolved.
12. During the operational demonstration many adjustments were performed on the systems operating variables. The soil processed during this early phase should be monitored in the sorter using optimized settings to increase assurances that the clean criteria was met.
13. Plant lighting should be provided for two shift operation.
14. Based on experience gained during the operational demonstration, order spare parts and operational supplies and send to the island in preparation for long term operation.

15. As time was available corrosion control measures were performed on equipment. Additional time should be allocated to provide additional corrosion control.

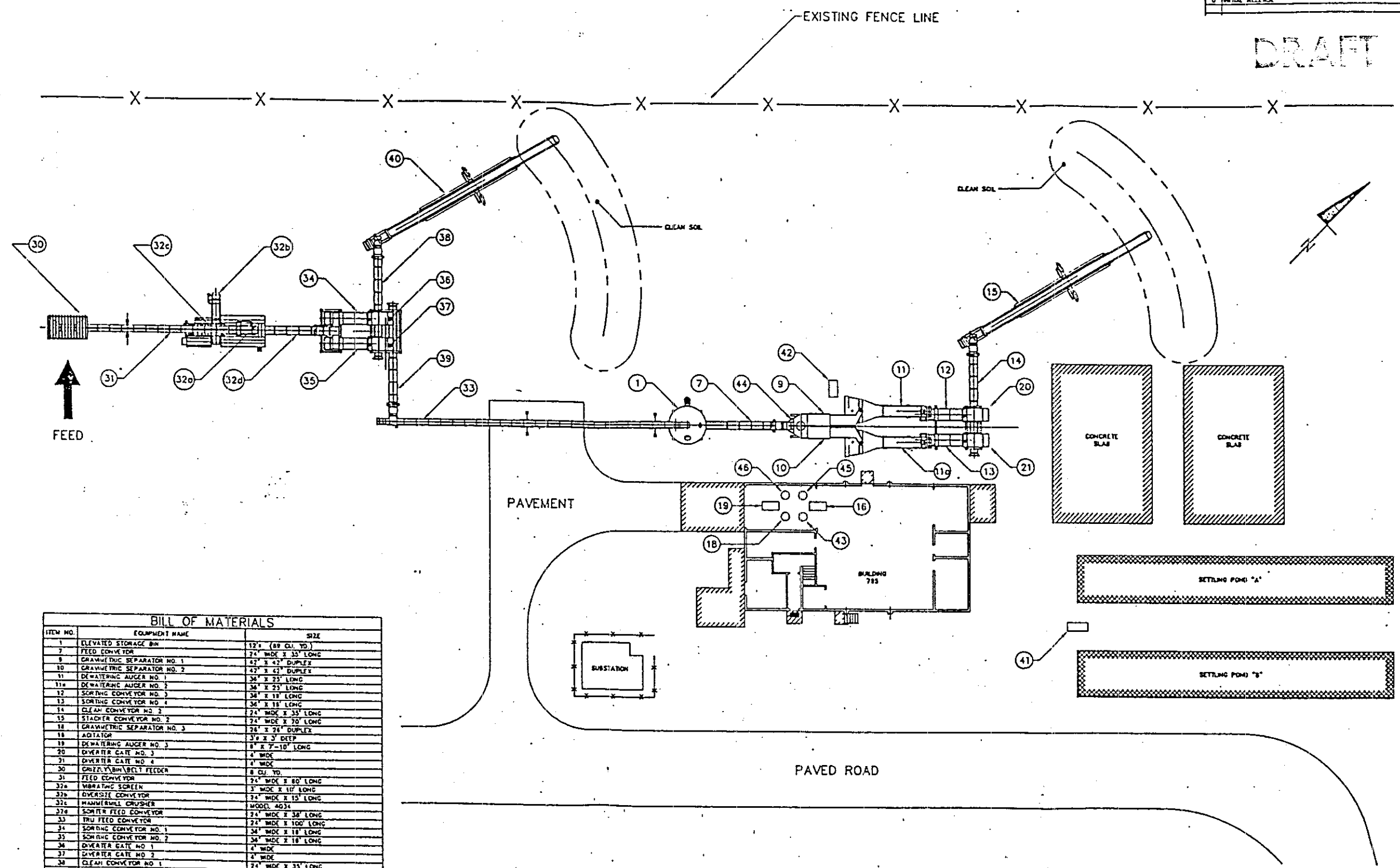
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- SU87d Sunderland, N.R., "The Removal of Plutonium Contaminants From BOMARC Missile Site Soil," AWC, Inc., Las Vegas, NV September 8, 1987
- SU87e Sunderland, N.R., "Area 13 Addendum to the Removal of Plutonium Contaminants From Area 11 Soil of the Nevada Test Site," AWC, Inc., Las Vegas, NV September 30, 1987

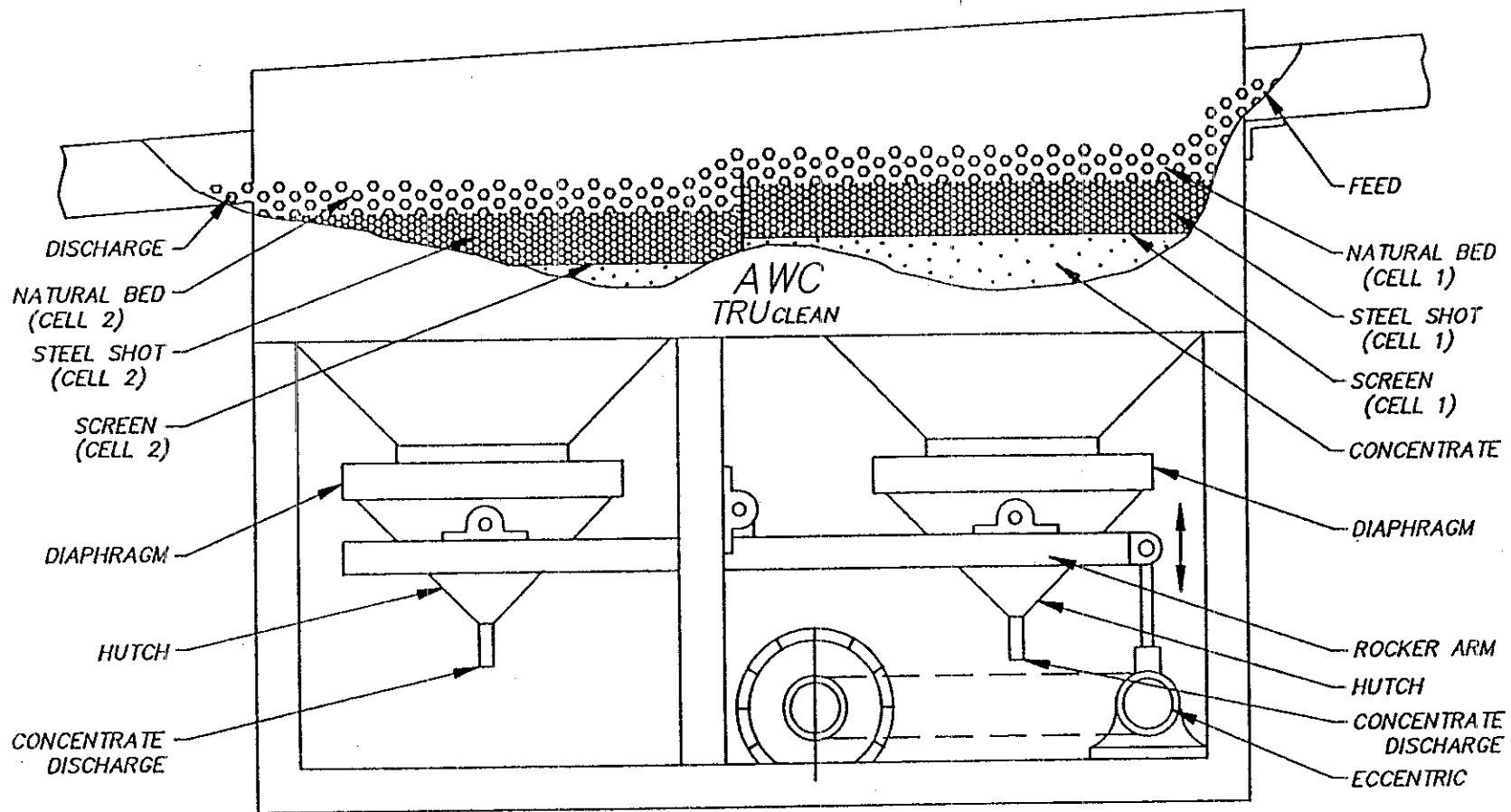
APPENDIX I

Figures 1 - 36

DRAFT

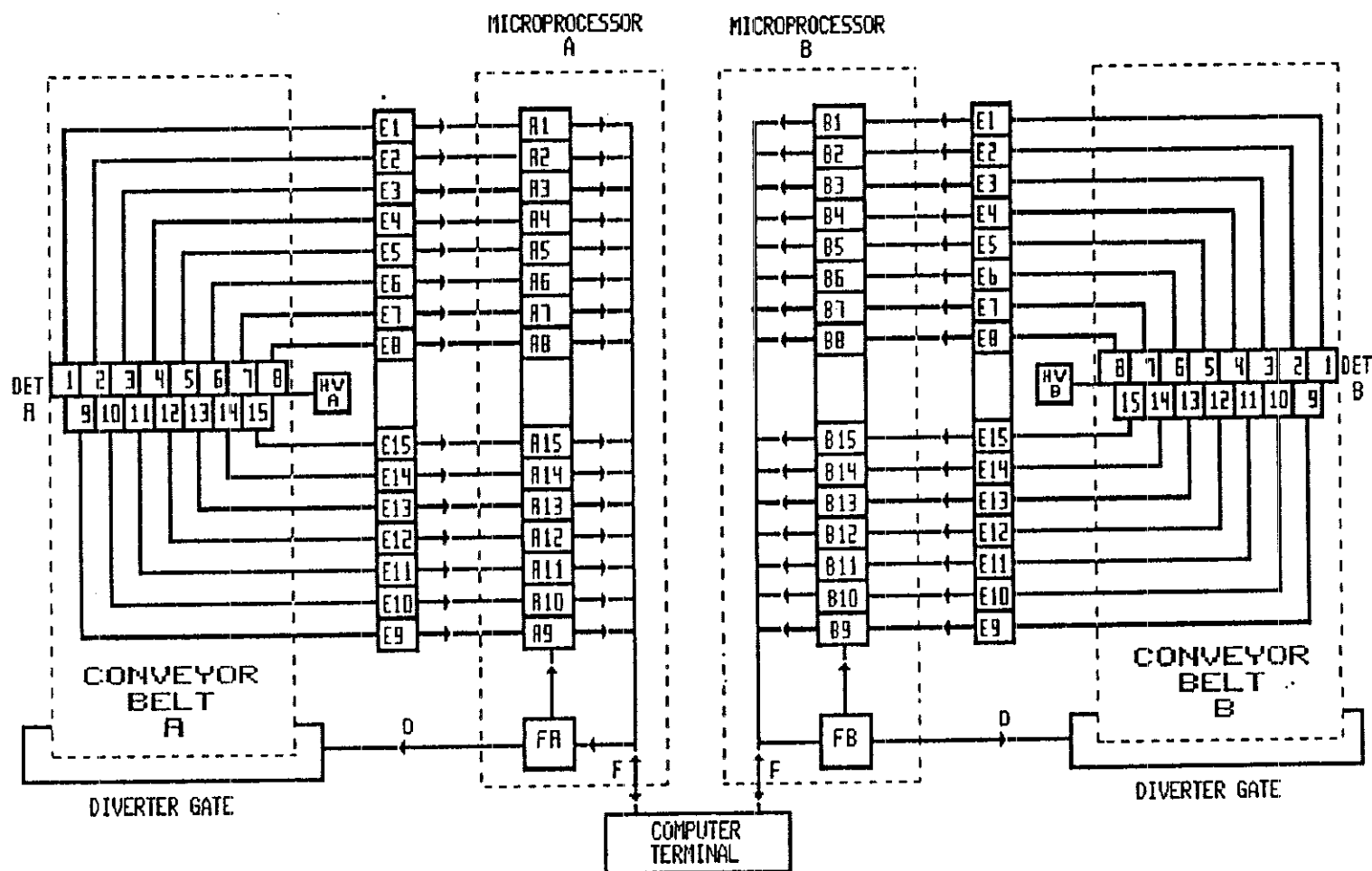


BILL OF MATERIALS		
ITEM NO.	EQUIPMENT NAME	SIZE
1	ELEVATED STORAGE BIN	12' x 8' (8' CL. TO)
2	FEED CONVEYOR	24" WIDE x 35' LONG
3	GRAVIMETRIC SEPARATOR NO. 1	42" x 42" DUPLEX
4	GRAVIMETRIC SEPARATOR NO. 2	42" x 42" DUPLEX
5	DEWATERING AUGER NO. 1	36" x 25' LONG
6	DEWATERING AUGER NO. 2	36" x 25' LONG
7	DEWATERING AUGER NO. 3	36" x 25' LONG
8	DEWATERING AUGER NO. 4	36" x 25' LONG
9	DEWATERING AUGER NO. 5	36" x 25' LONG
10	DEWATERING AUGER NO. 6	36" x 25' LONG
11	DEWATERING AUGER NO. 7	36" x 25' LONG
12	DEWATERING AUGER NO. 8	36" x 25' LONG
13	DEWATERING AUGER NO. 9	36" x 25' LONG
14	DEWATERING AUGER NO. 10	36" x 25' LONG
15	DEWATERING AUGER NO. 11	36" x 25' LONG
16	DEWATERING AUGER NO. 12	36" x 25' LONG
17	DEWATERING AUGER NO. 13	36" x 25' LONG
18	DEWATERING AUGER NO. 14	36" x 25' LONG
19	DEWATERING AUGER NO. 15	36" x 25' LONG
20	DEWATERING AUGER NO. 16	36" x 25' LONG
21	DEWATERING AUGER NO. 17	36" x 25' LONG
22	DEWATERING AUGER NO. 18	36" x 25' LONG
23	DEWATERING AUGER NO. 19	36" x 25' LONG
24	DEWATERING AUGER NO. 20	36" x 25' LONG
25	DEWATERING AUGER NO. 21	36" x 25' LONG
26	DEWATERING AUGER NO. 22	36" x 25' LONG
27	DEWATERING AUGER NO. 23	36" x 25' LONG
28	DEWATERING AUGER NO. 24	36" x 25' LONG
29	DEWATERING AUGER NO. 25	36" x 25' LONG
30	DEWATERING AUGER NO. 26	36" x 25' LONG
31	DEWATERING AUGER NO. 27	36" x 25' LONG
32	DEWATERING AUGER NO. 28	36" x 25' LONG
33	DEWATERING AUGER NO. 29	36" x 25' LONG
34	DEWATERING AUGER NO. 30	36" x 25' LONG
35	DEWATERING AUGER NO. 31	36" x 25' LONG
36	DEWATERING AUGER NO. 32	36" x 25' LONG
37	DEWATERING AUGER NO. 33	36" x 25' LONG
38	DEWATERING AUGER NO. 34	36" x 25' LONG
39	DEWATERING AUGER NO. 35	36" x 25' LONG
40	DEWATERING AUGER NO. 36	36" x 25' LONG
41	DEWATERING AUGER NO. 37	36" x 25' LONG
42	DEWATERING AUGER NO. 38	36" x 25' LONG
43	DEWATERING AUGER NO. 39	36" x 25' LONG
44	DEWATERING AUGER NO. 40	36" x 25' LONG
45	DEWATERING AUGER NO. 41	36" x 25' LONG
46	DEWATERING AUGER NO. 42	36" x 25' LONG



GRAVIMETRIC SEPARATOR

FIGURE 2



KEY

- DET A - NaI Detector Module A
- DET B - NaI Detector module B
- D - Diversion Signal
- F - Fiber Optic Link
- FA - Firmware A
- FB - Firmware B
- HV A - High Voltage Module A
- HV B - High Voltage Module B
- E1 through E15 - Signal processing for detectors E1 through E15.
(1 preamp, 1 amp, 3 SCAs per detector)
- A1 through A15 - Data Storage Buffers for Detectors A1 through A15
(6 buffers per detector)
- B1 through B15 - Data Storage Buffers for Detectors B1 through B15
(6 buffers per detector)

FIGURE 3 - MONITORING SYSTEM

FIGURE 4 AM-241 SPECTRUM

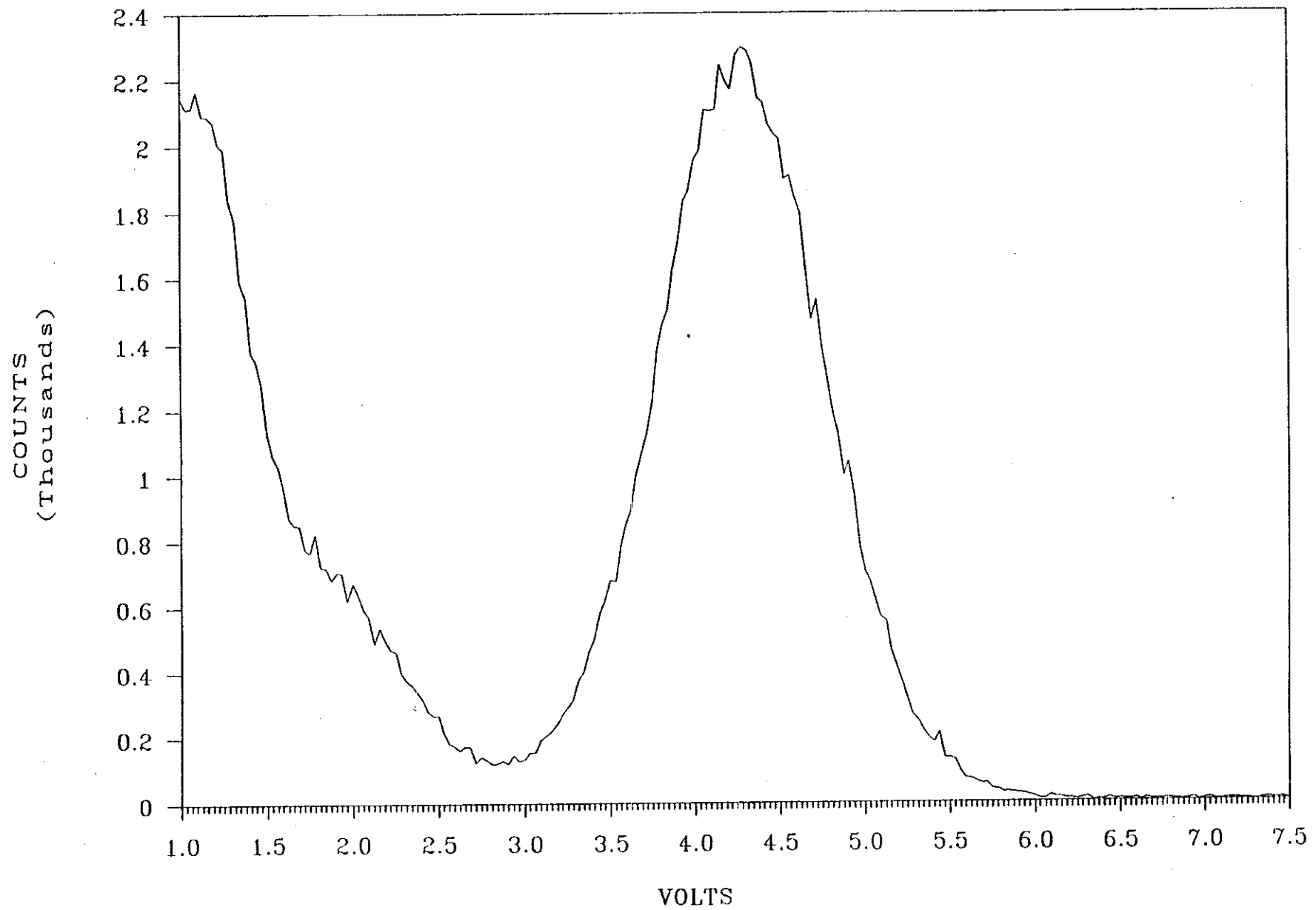


FIGURE 5 SOIL SIZE DISTRIBUTION

GARVIN 1985

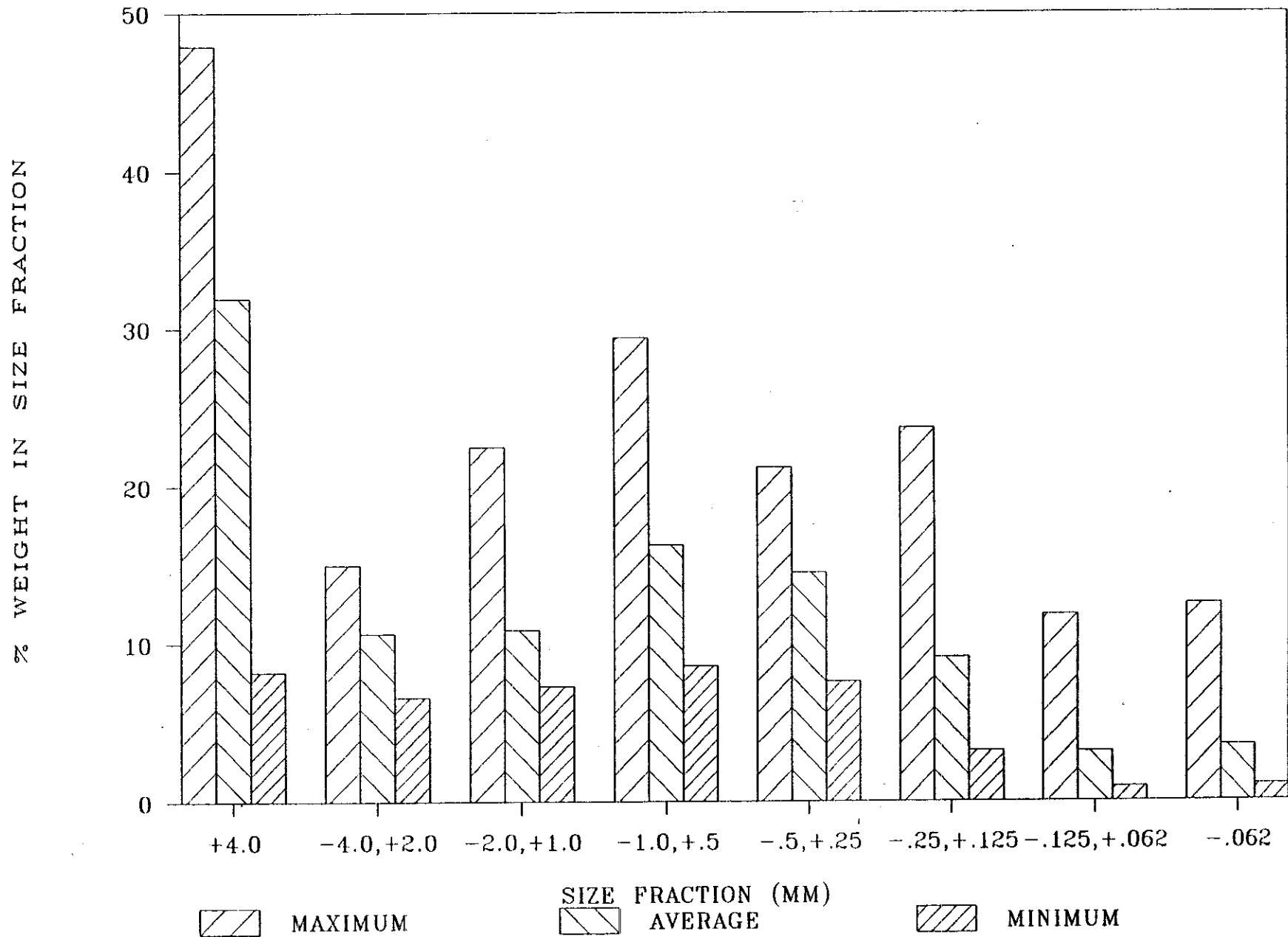


FIGURE 6 SOIL SIZE DISTRIBUTION

1985 KOCHEN

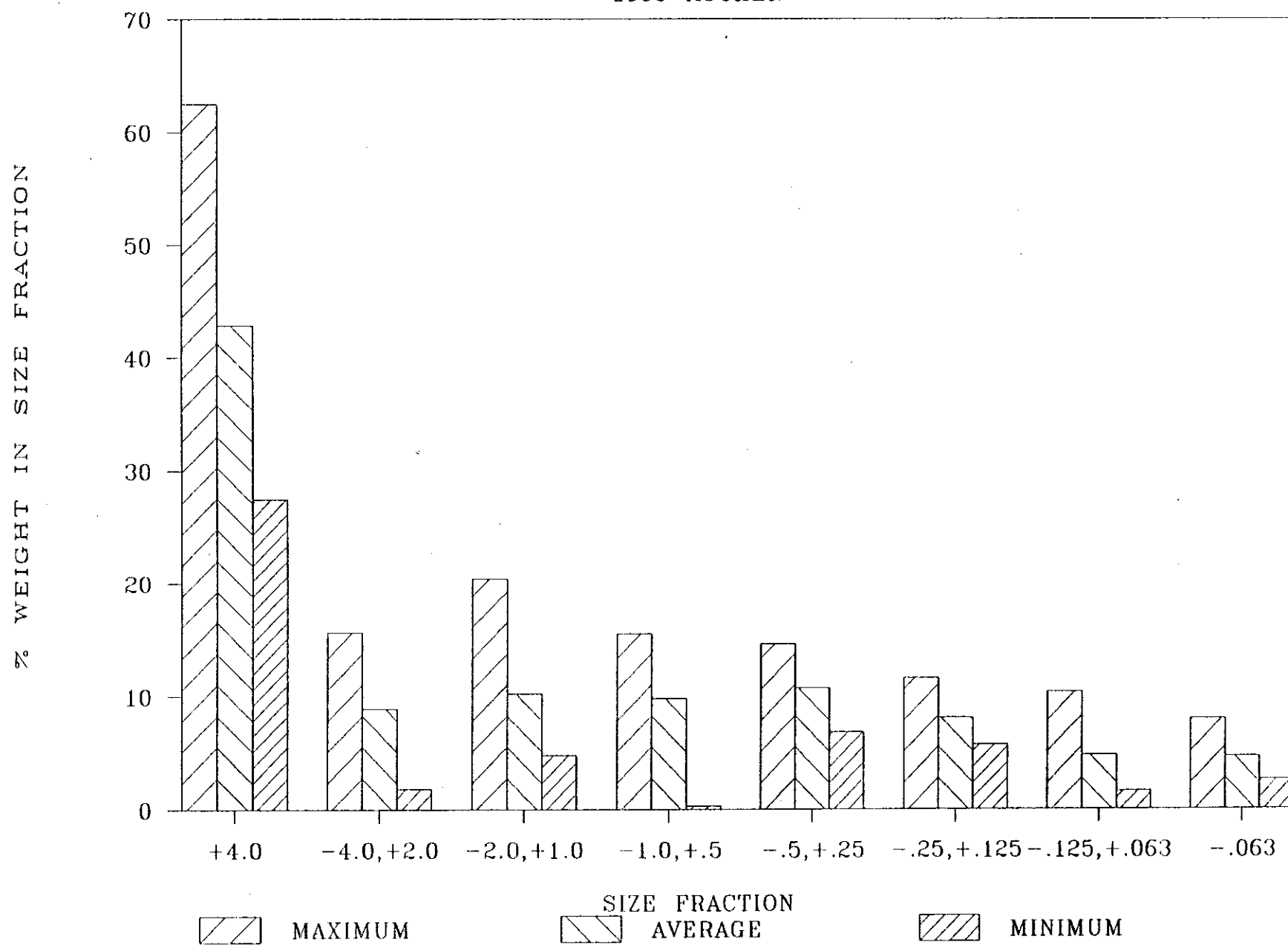


FIGURE 7 MAXIMUM PARTICLE ACTIVITY

KOCHEN 1985

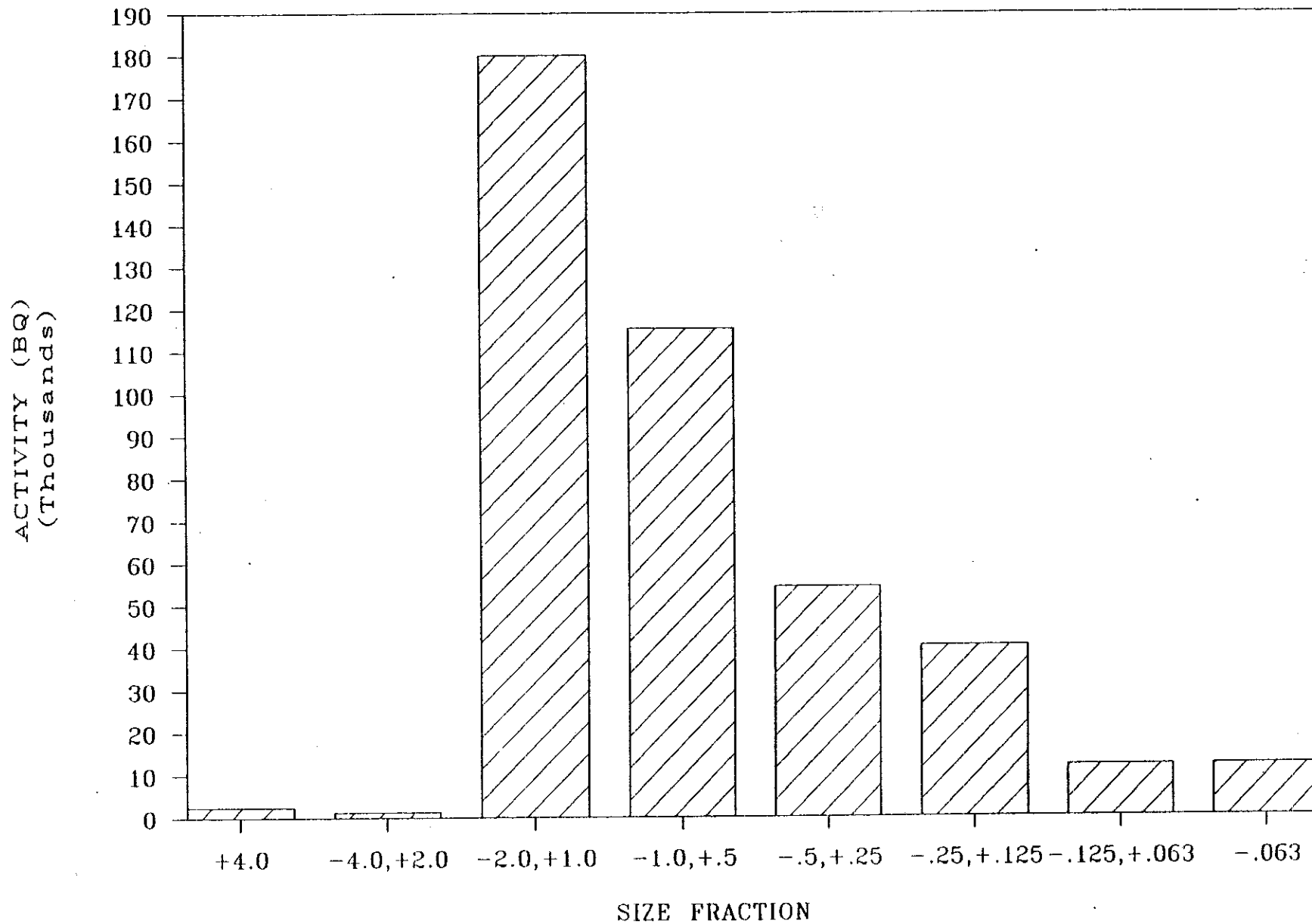


FIGURE 8 SUMMARY OF 1988 SIZING STUDY

POSITIVE RADIOACTIVITY BY SIZE FRACTION

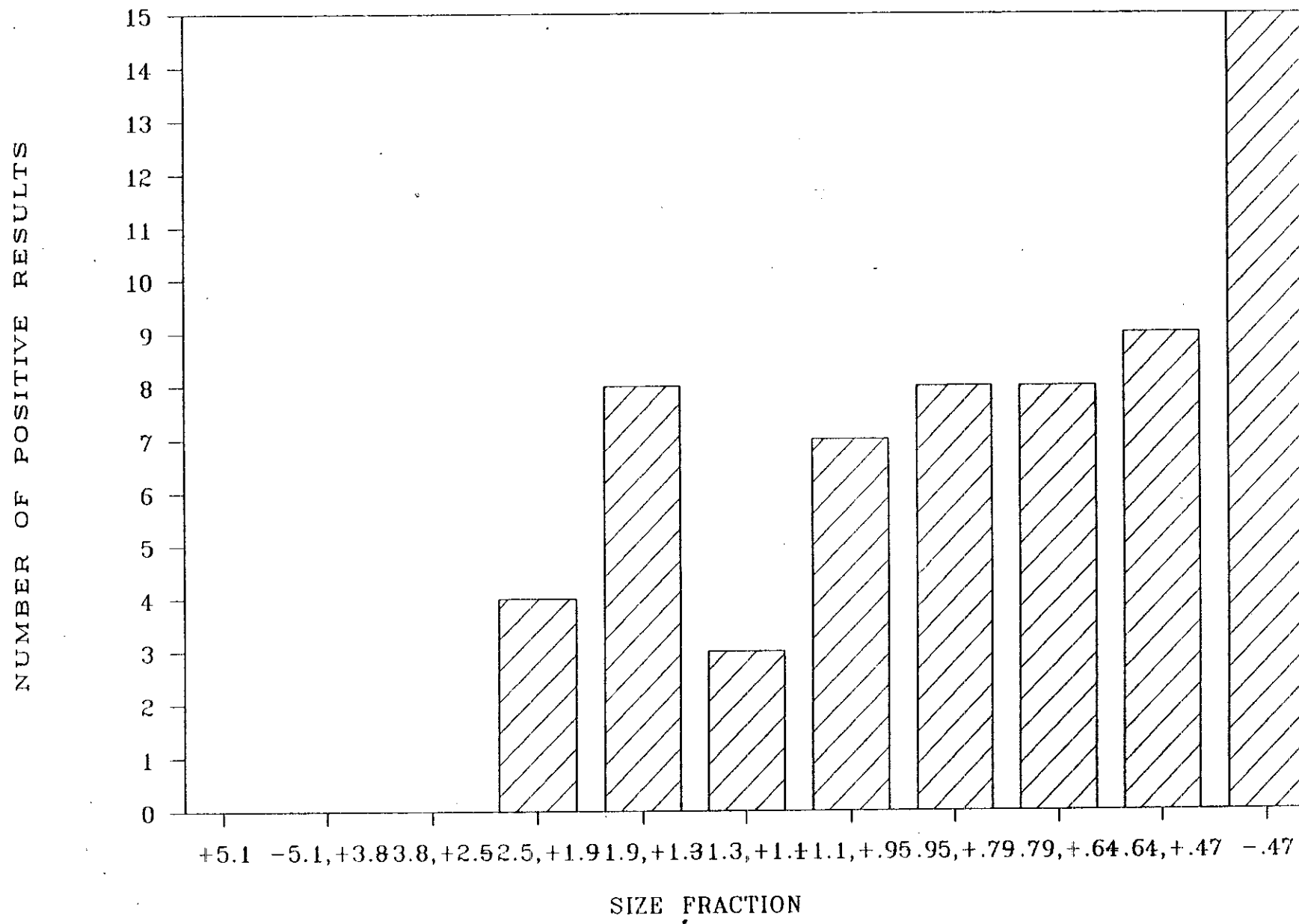


FIGURE 9

PLUTONIUM PARTICLE SIZE AND ACTIVITY

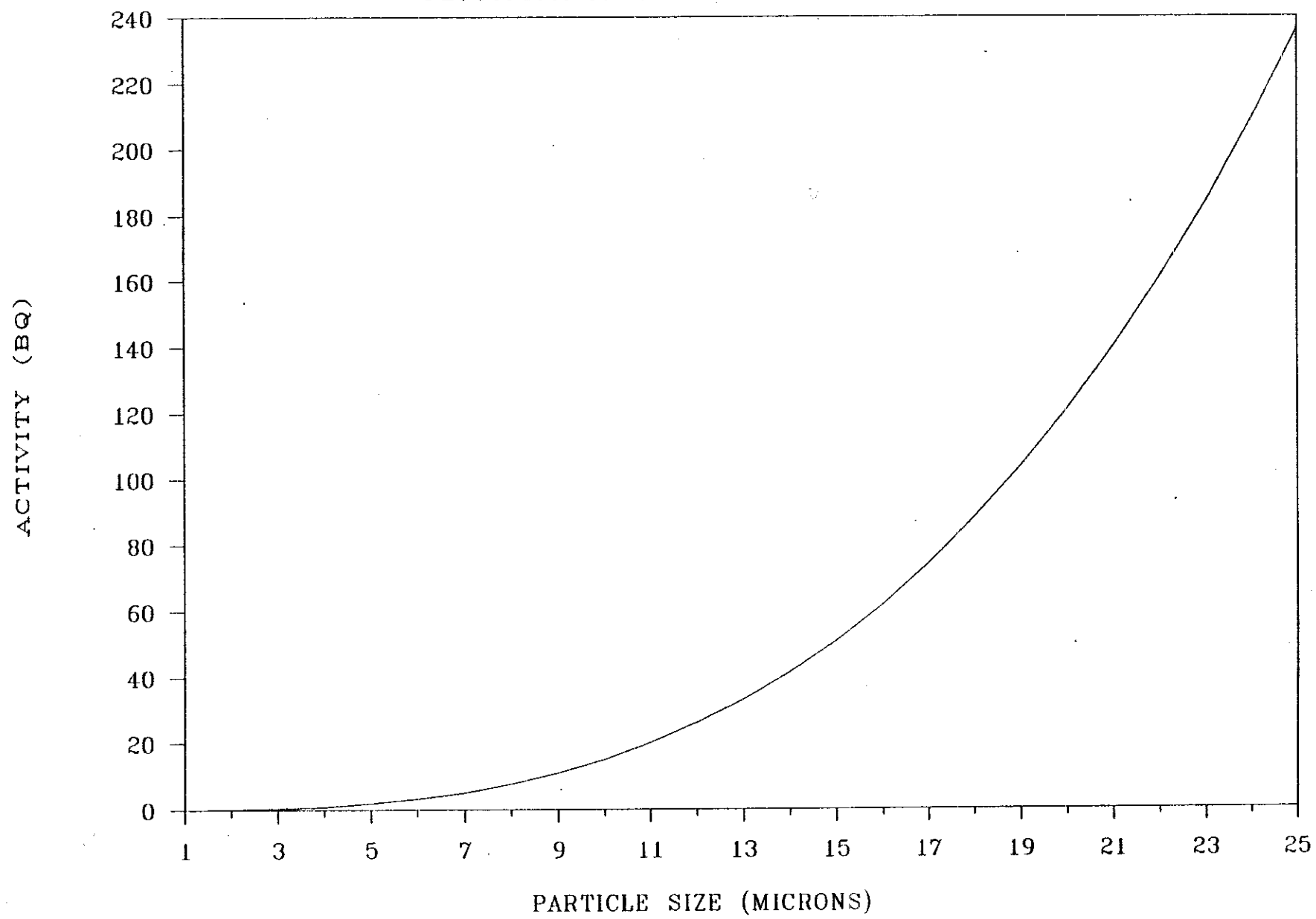


FIGURE 9 (CONTINUED)

PLUTONIUM PARTICLE SIZE AND ACTIVITY

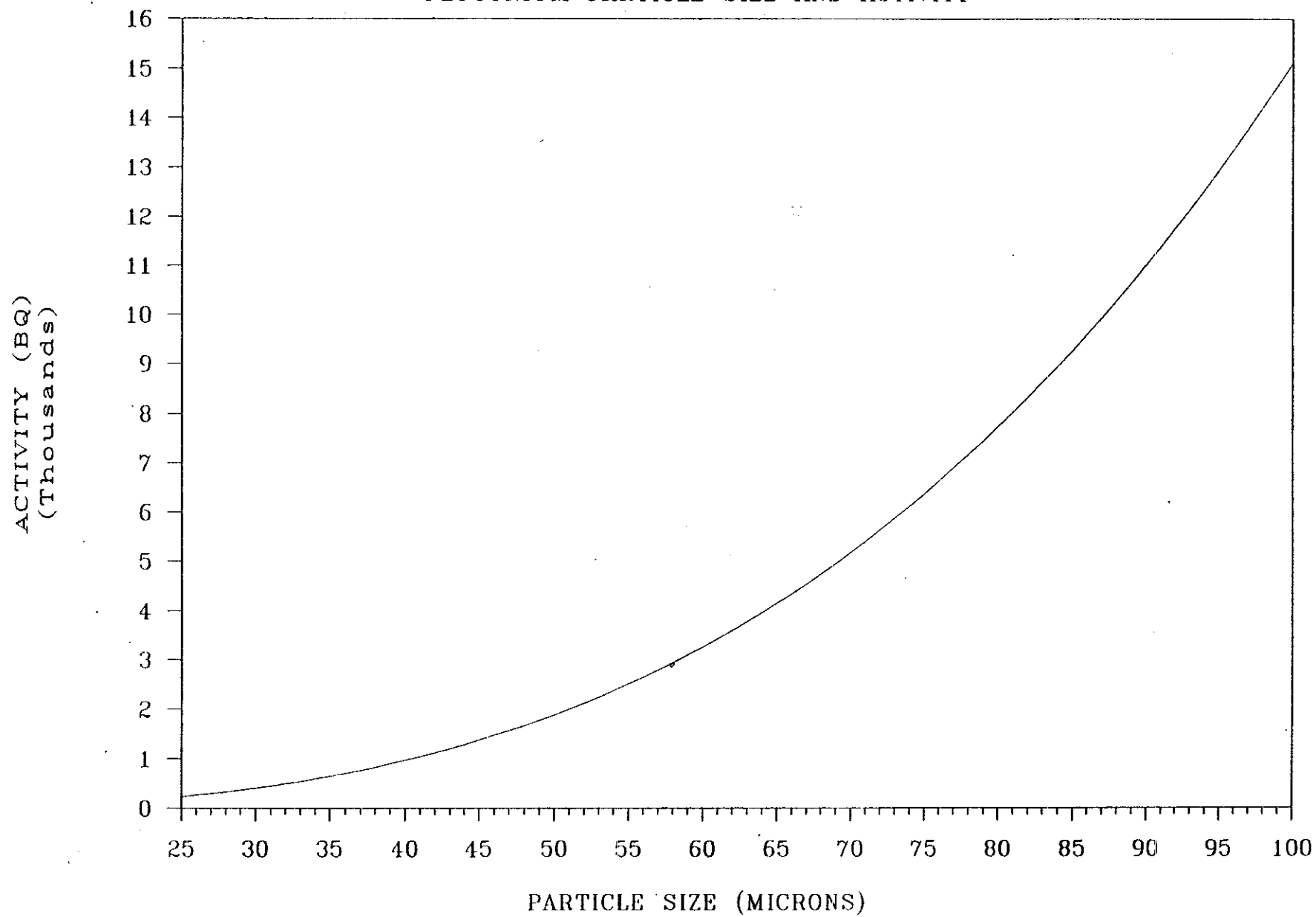
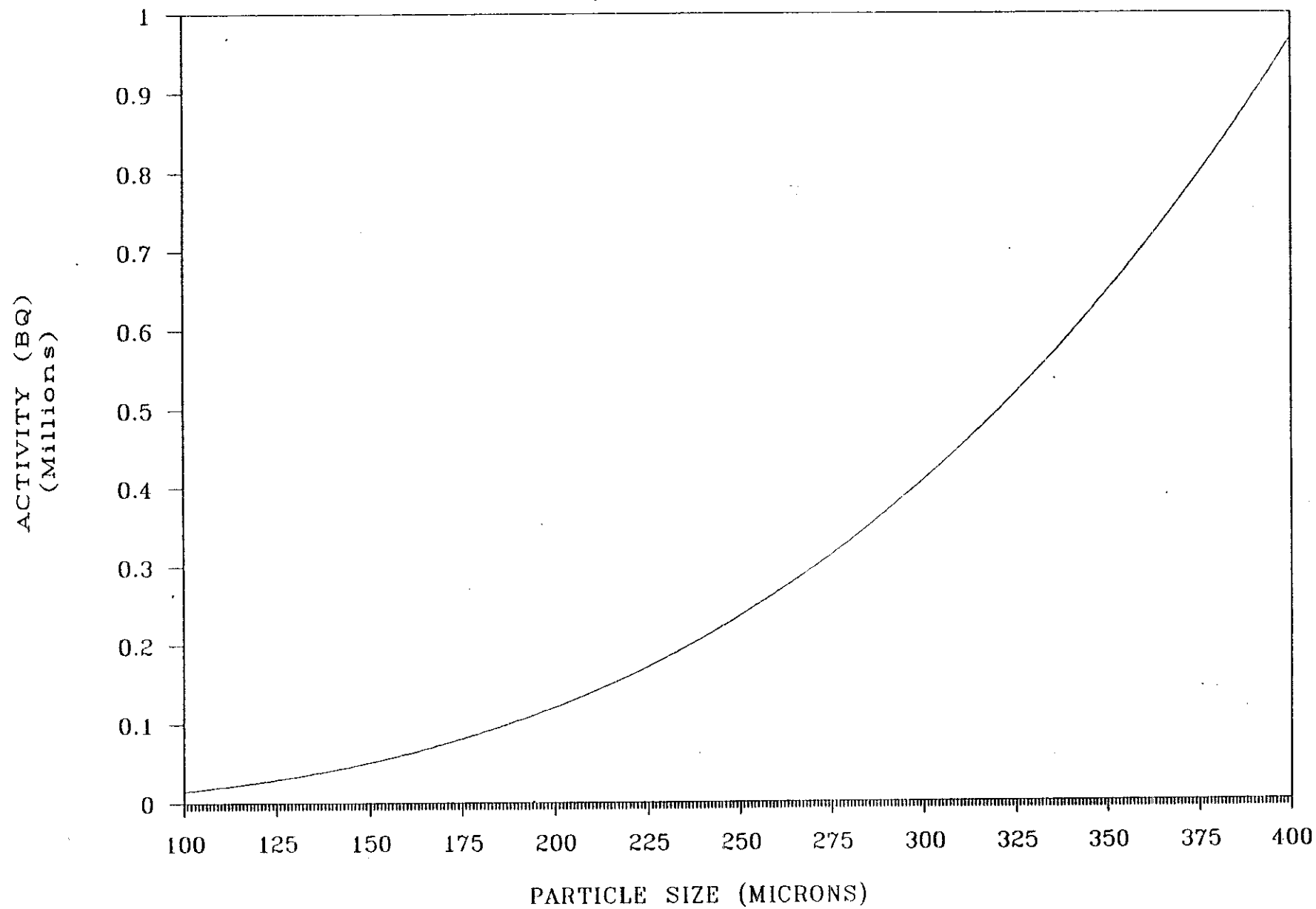


FIGURE 9 (CONTINUED)
PLUTONIUM PARTICLE SIZE AND ACTIVITY



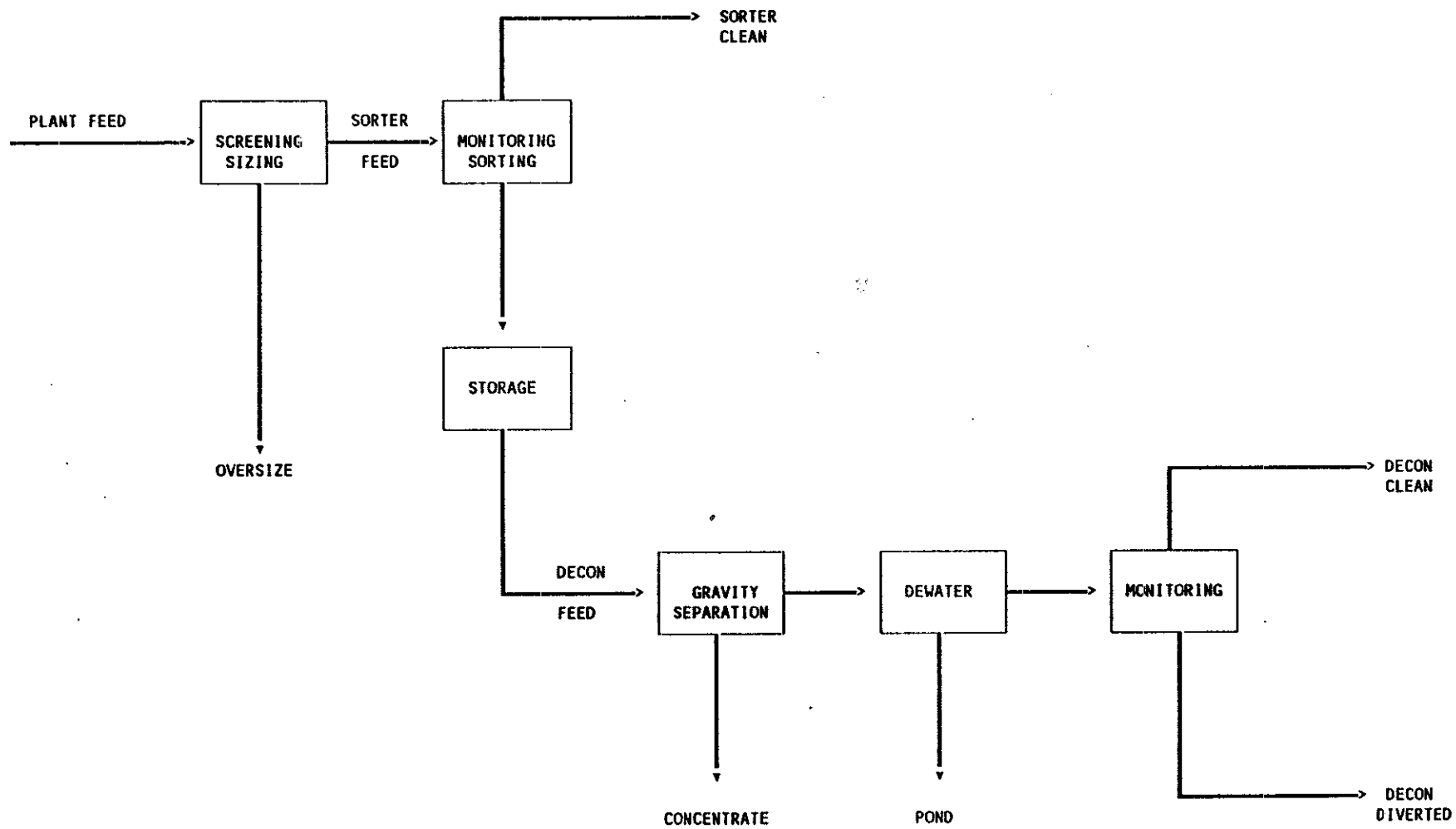


FIGURE 10 - MATERIAL FLOW DIAGRAM

FIGURE 11 MATERIAL BALANCE (INITIAL)

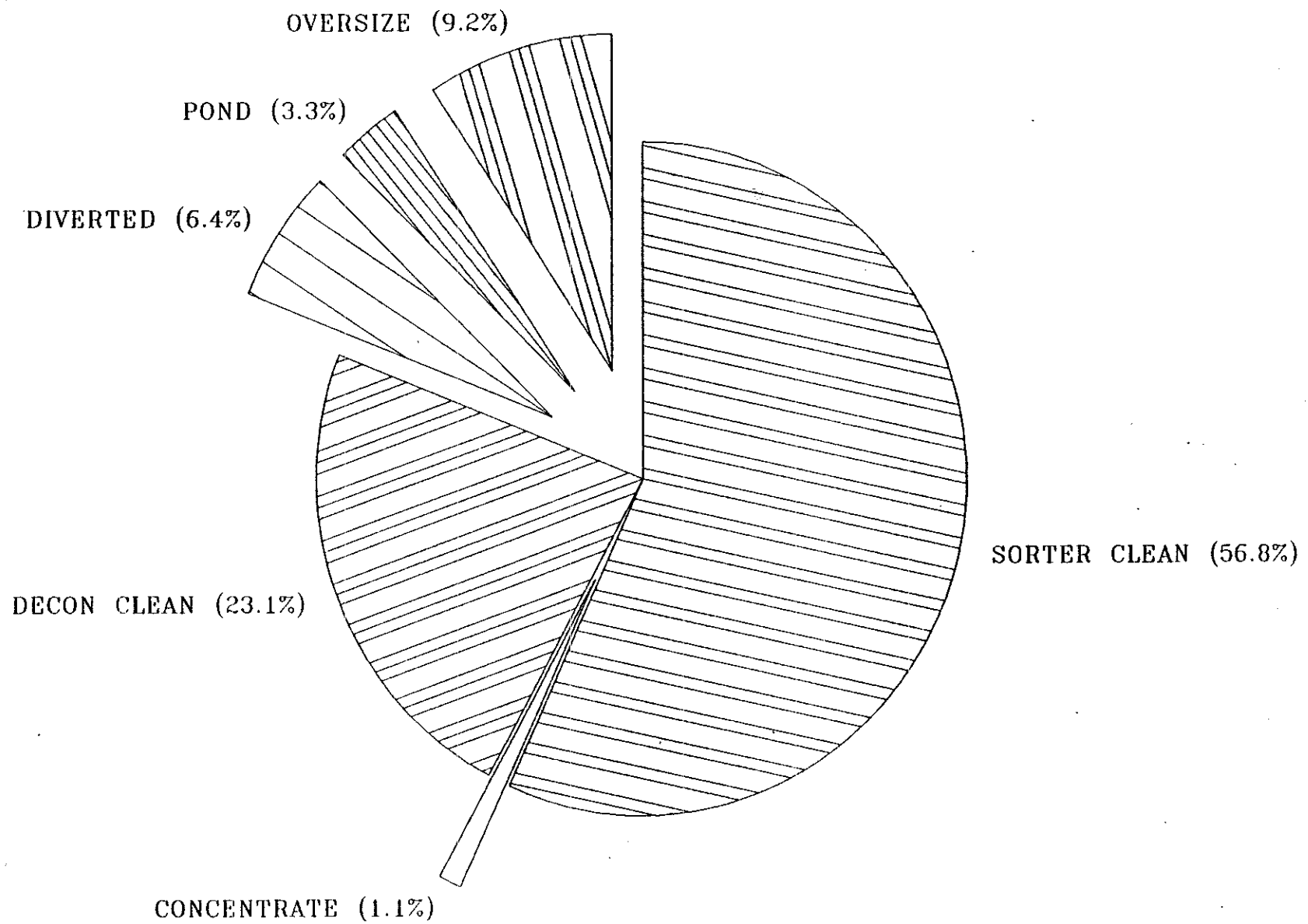


FIGURE 12 PROJECTED MATERIAL BALANCE

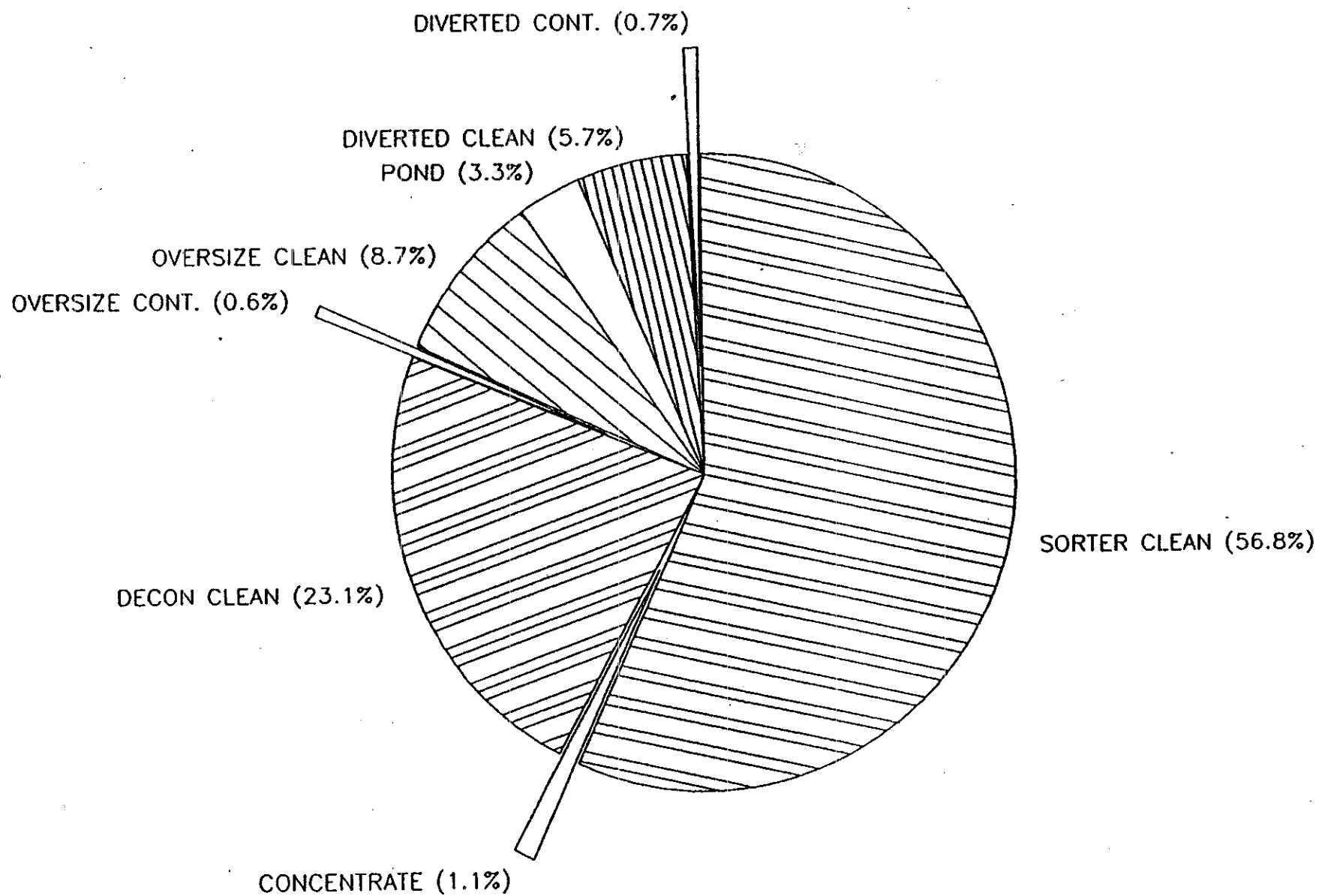


FIGURE 13 SORTER PERFORMANCE

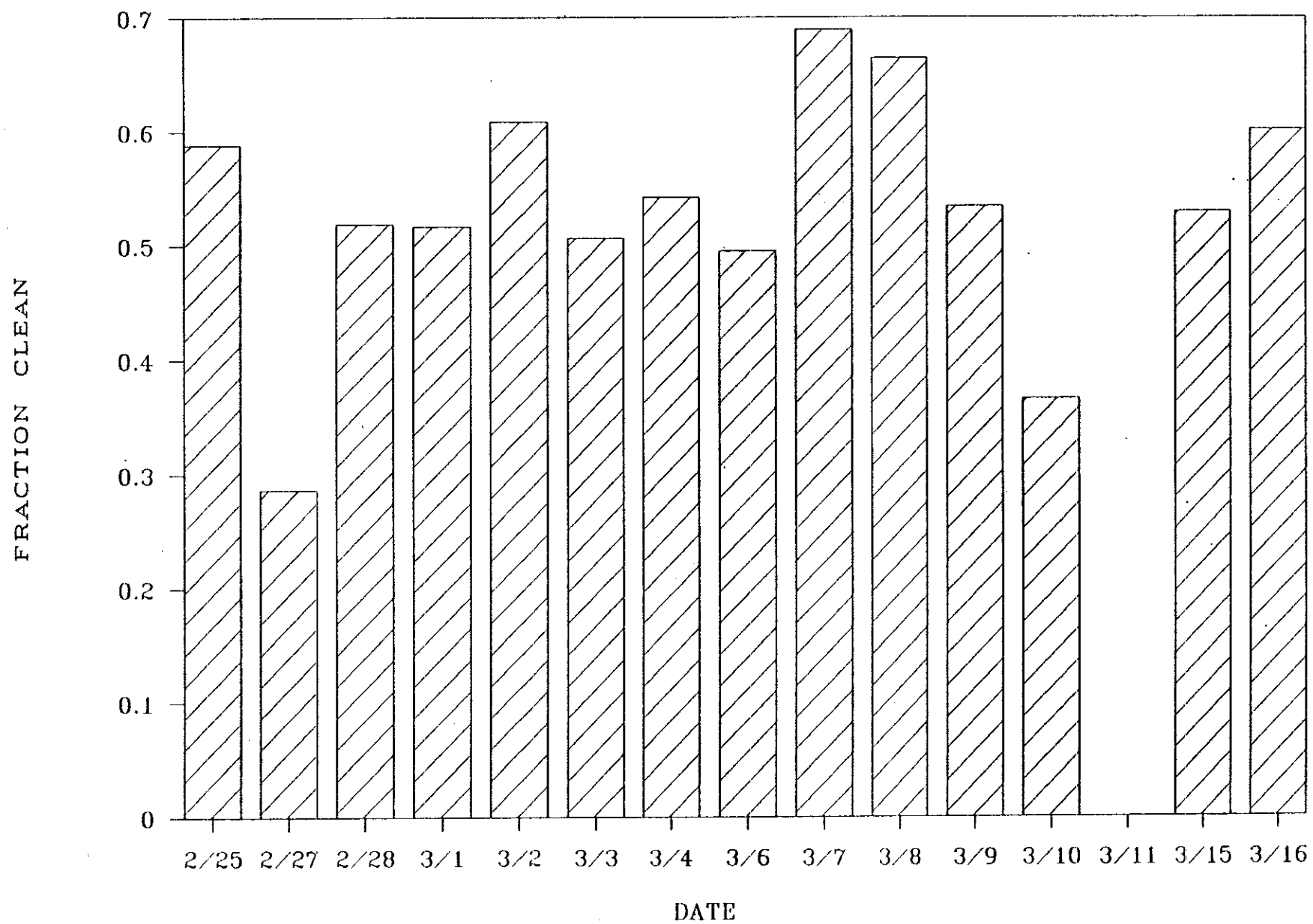


FIGURE 14 PILOT PLANT PARTICLE STUDY

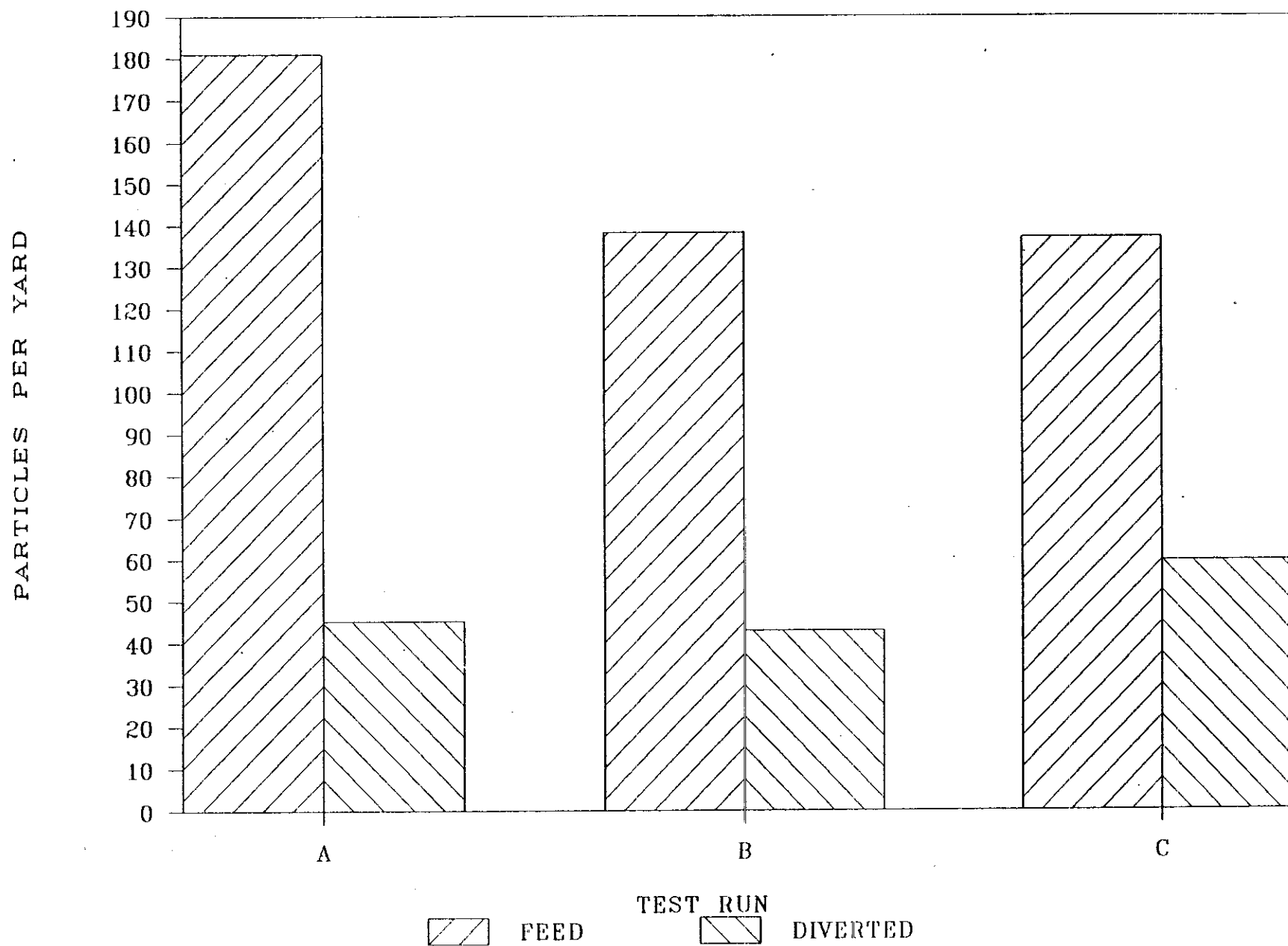


FIGURE 15 PILOT PLANT ACTIVITY STUDY

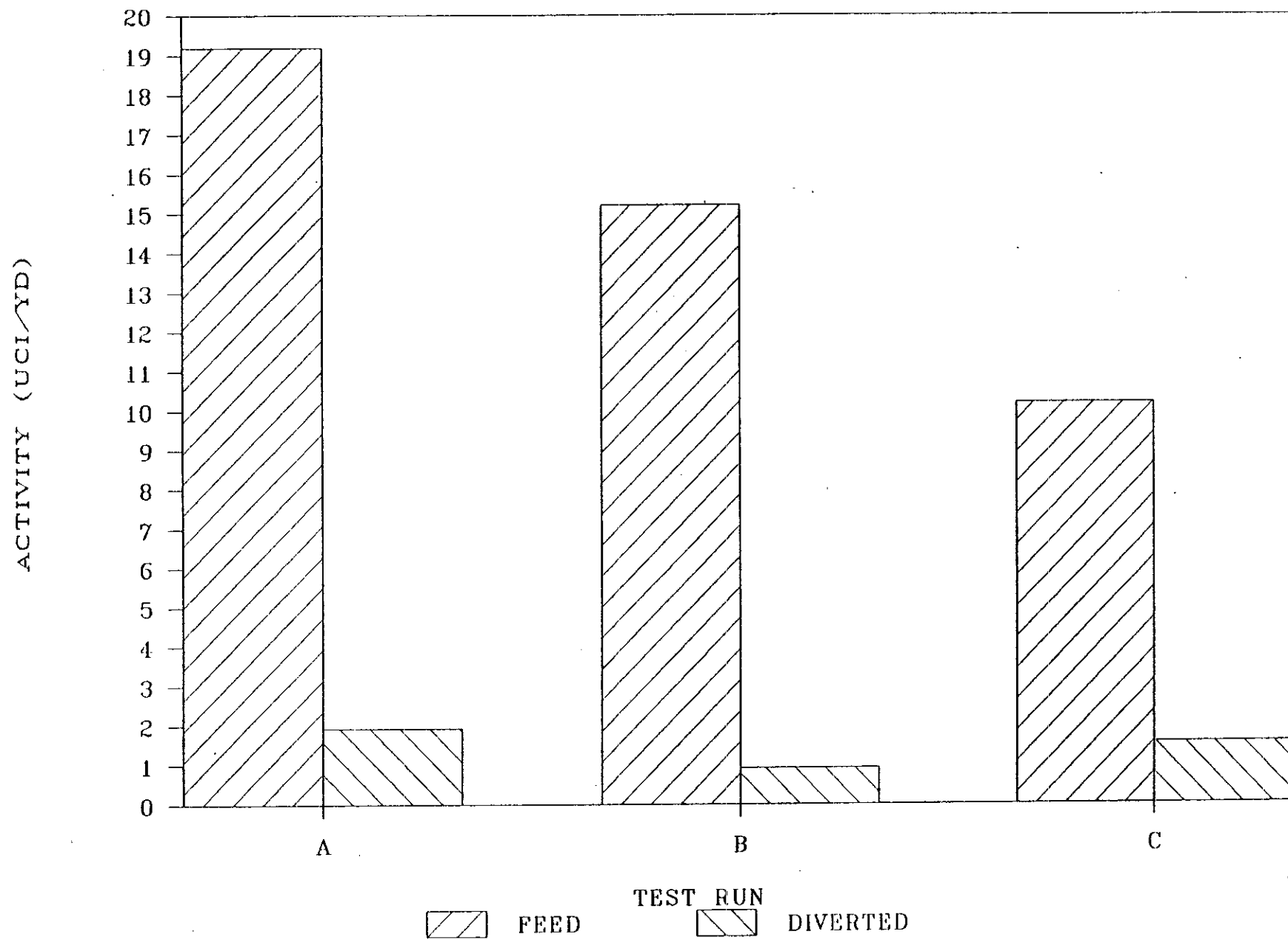


FIGURE 16

PRODUCTION PLANT PARTICLE ESTIMATES

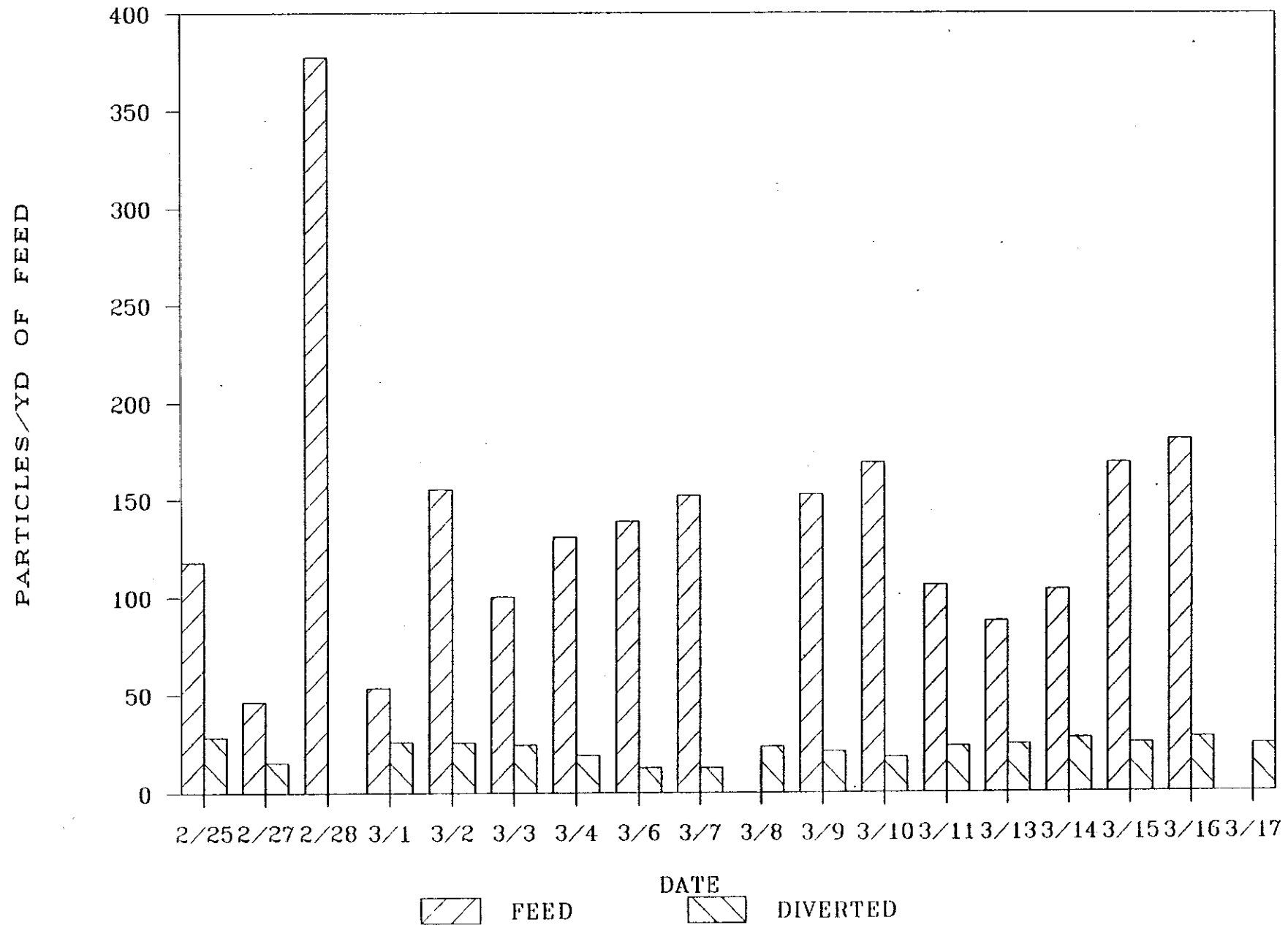


FIGURE 17 CONC. ACTIVITY & DIVERSIONS
PER YARD OF FEED

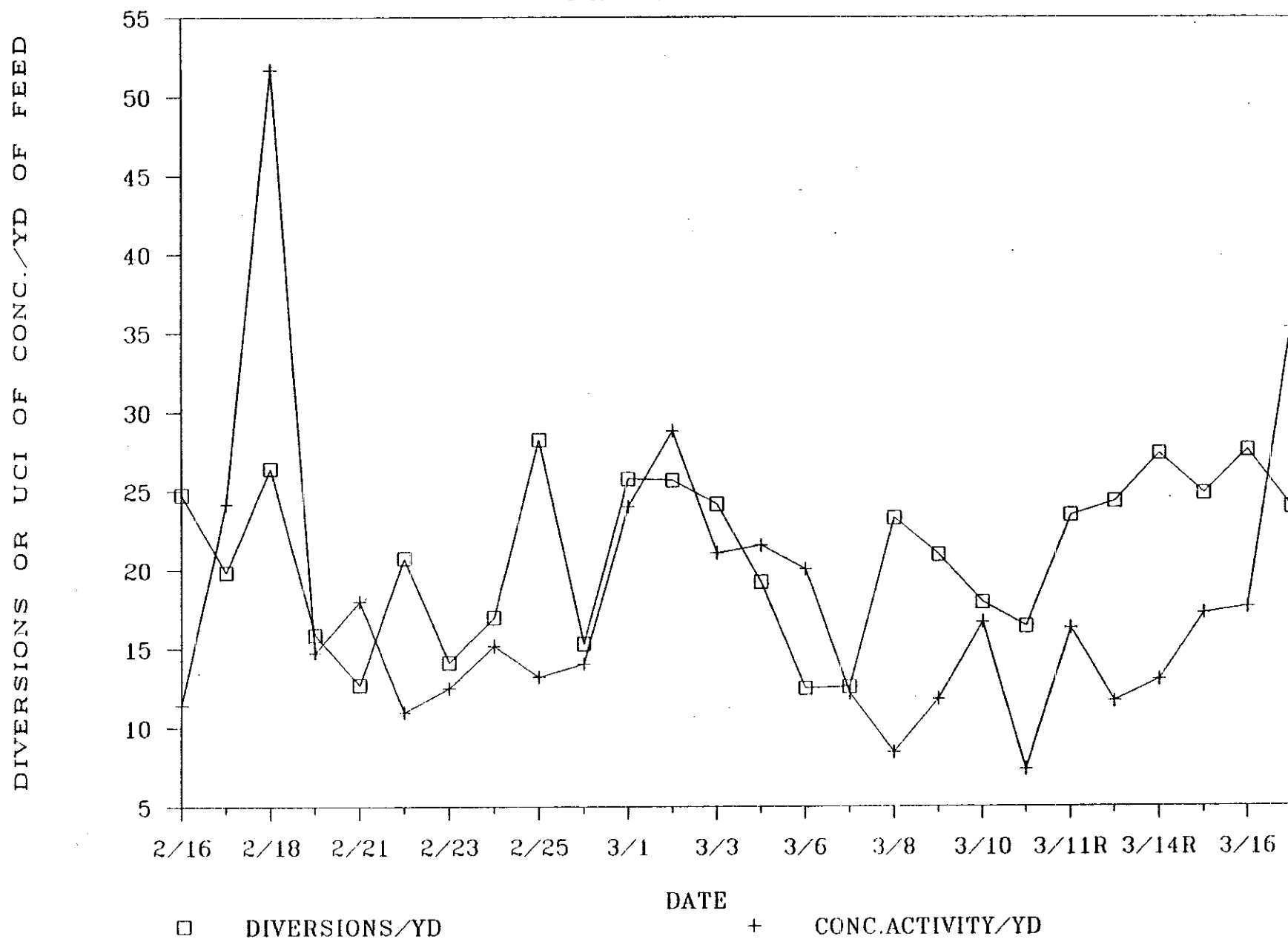


FIGURE 18

CONCENTRATE CONTAINER ACTIVITY

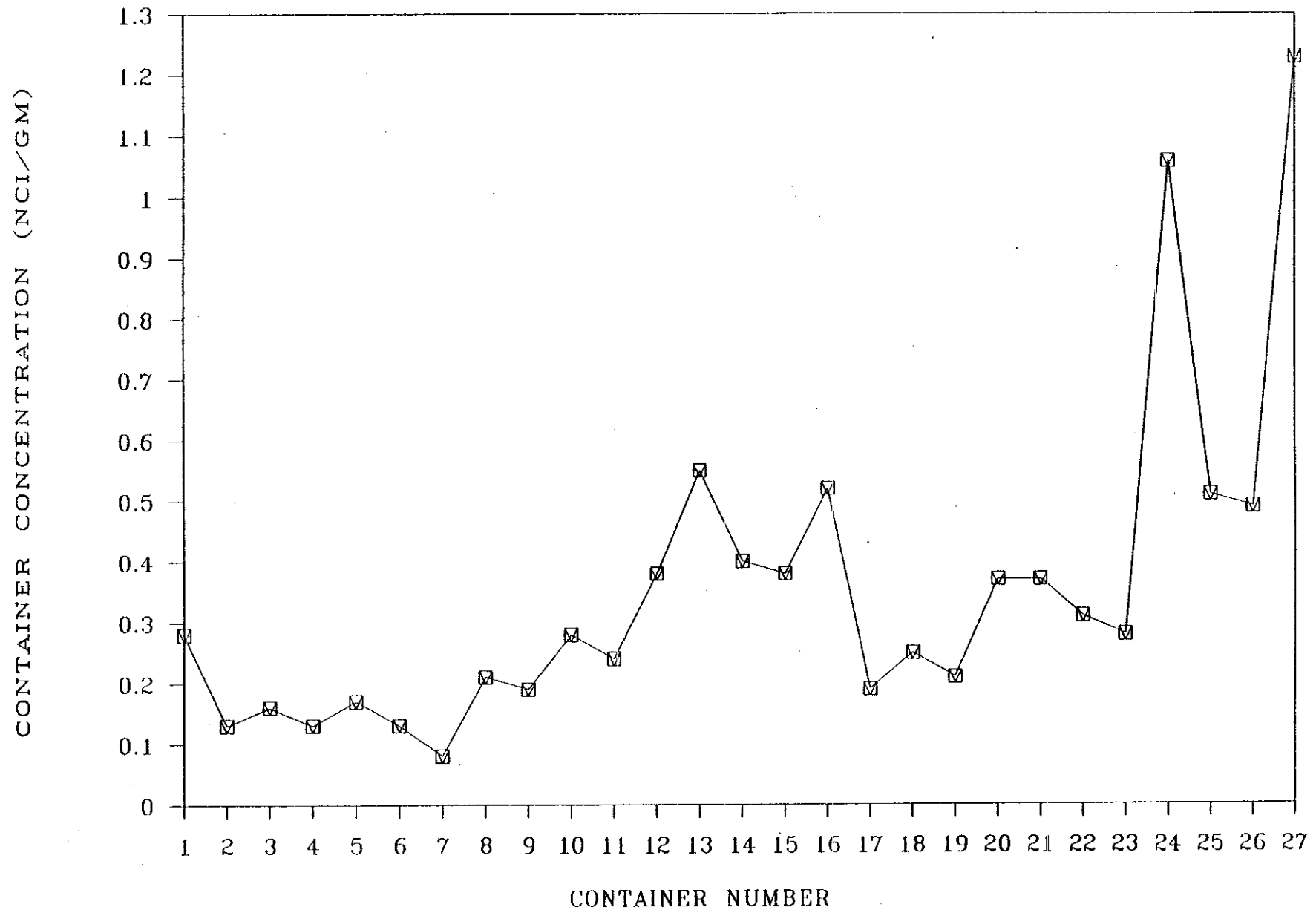


FIGURE 19 CONCENTRATE VOLUME

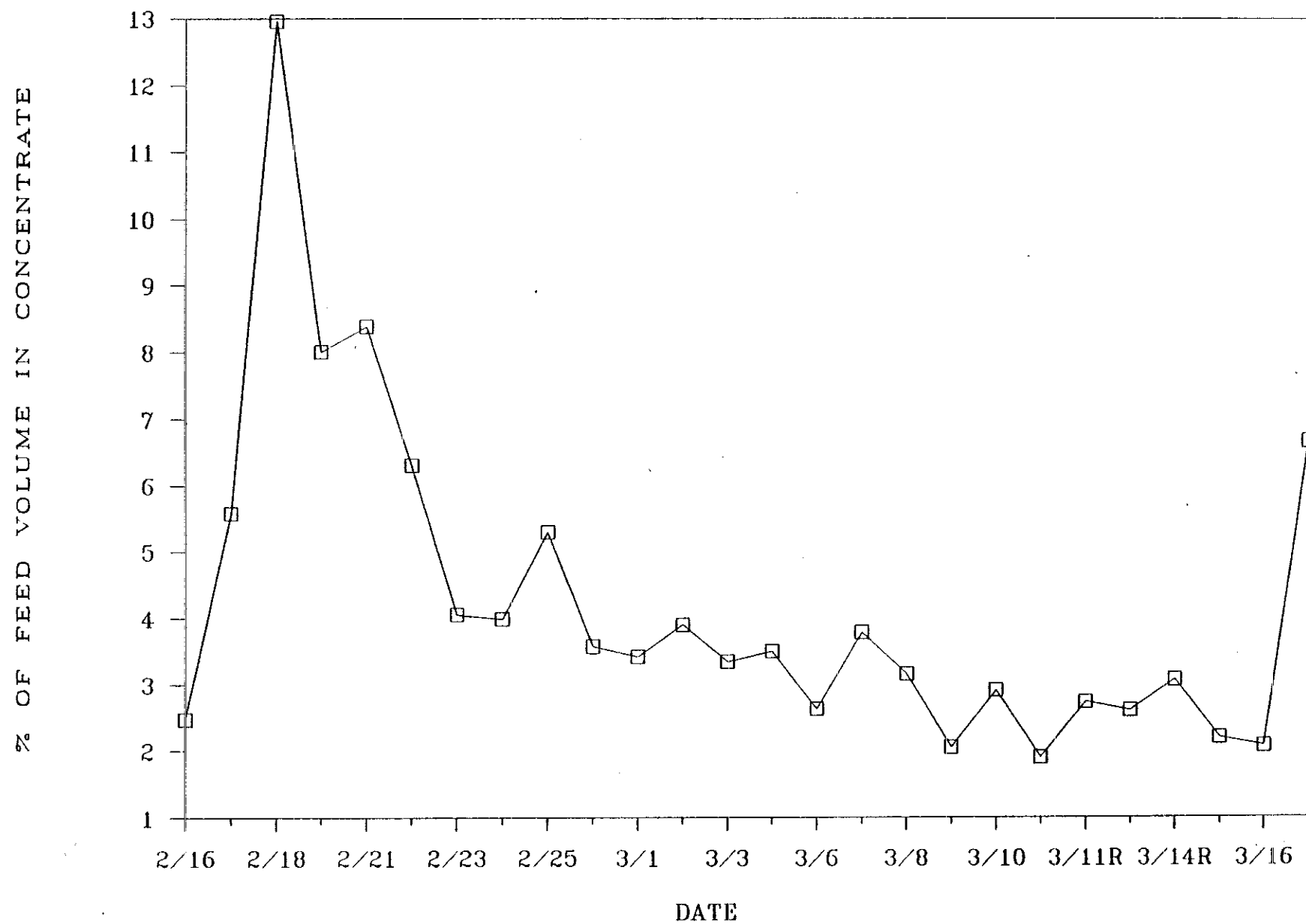


FIGURE 20 DECON PLANT DIVERSIONS

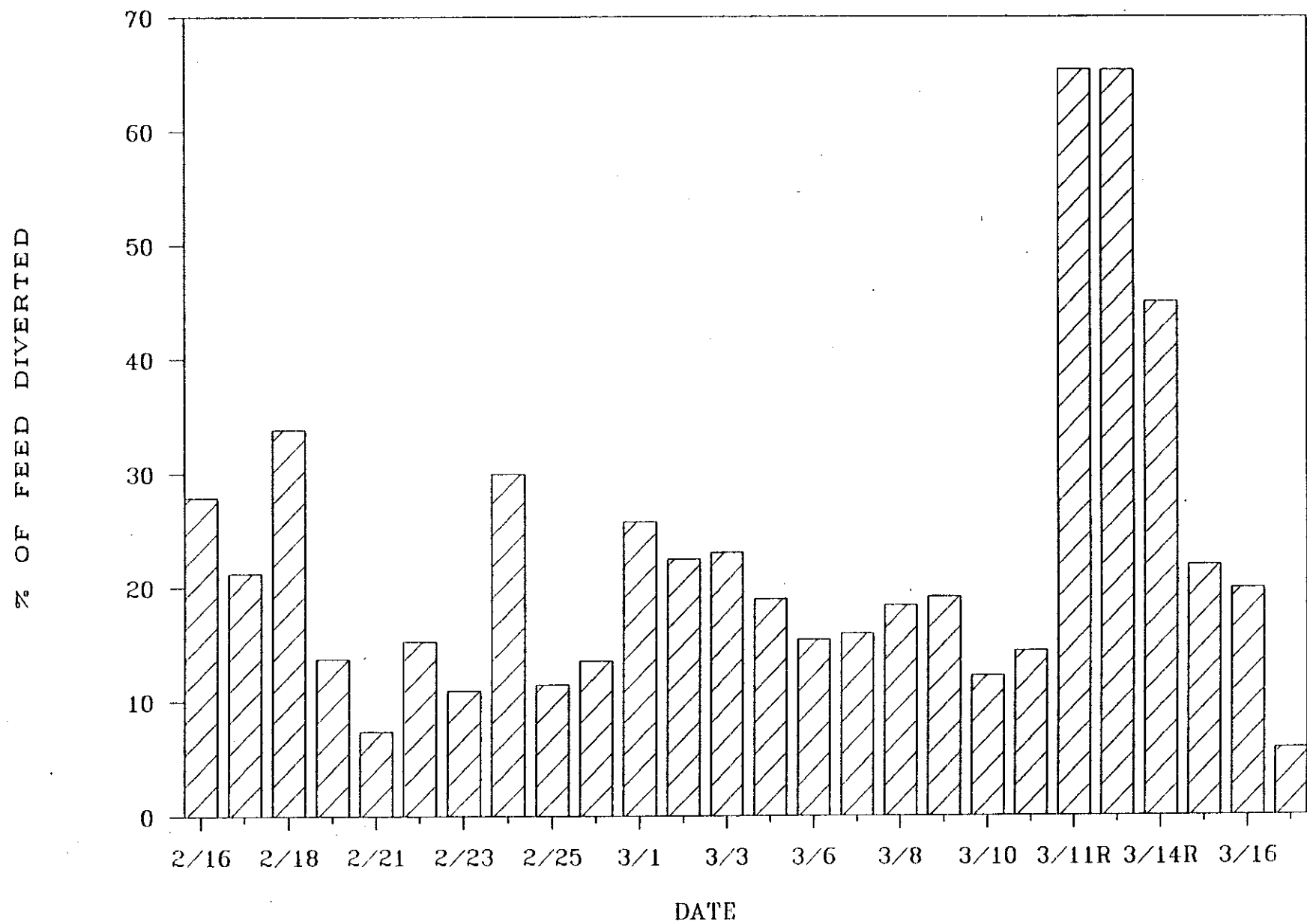
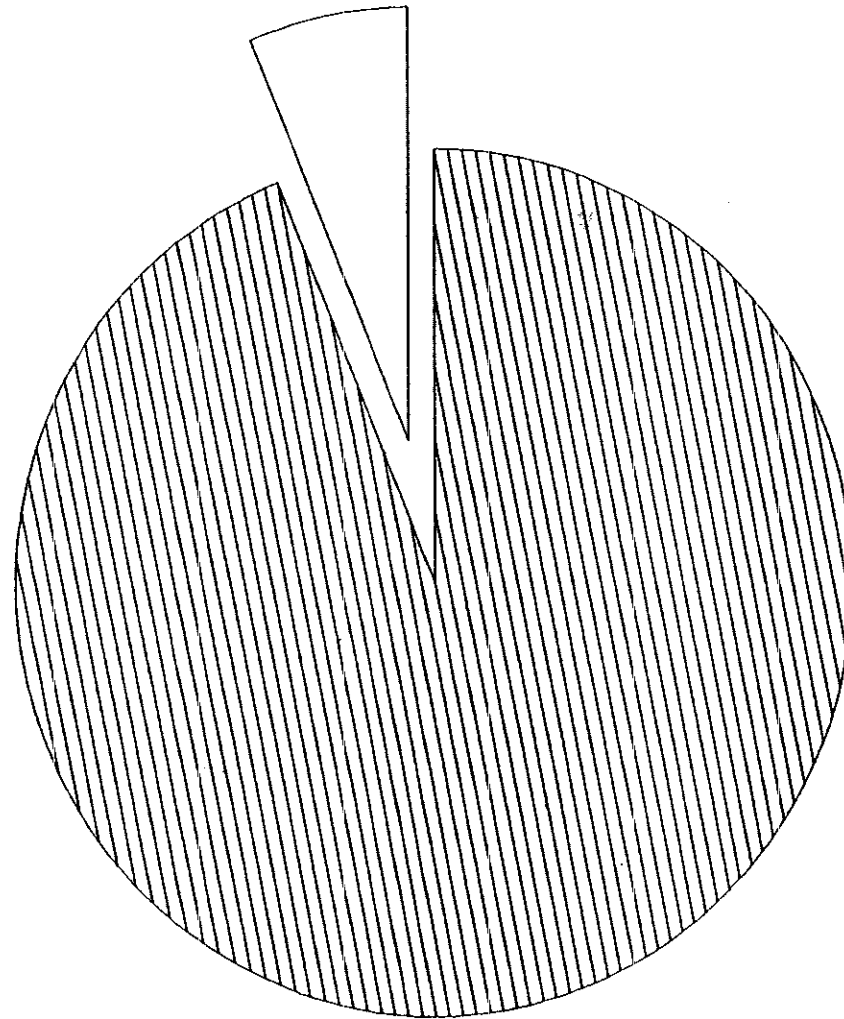


FIGURE 21 OVERSIZE TEST

OVERSIZE CONTAMINATED (6.2%)



OVERSIZE CLEAN (93.8%)

FIGURE 22 DIVERTED RERUN TEST

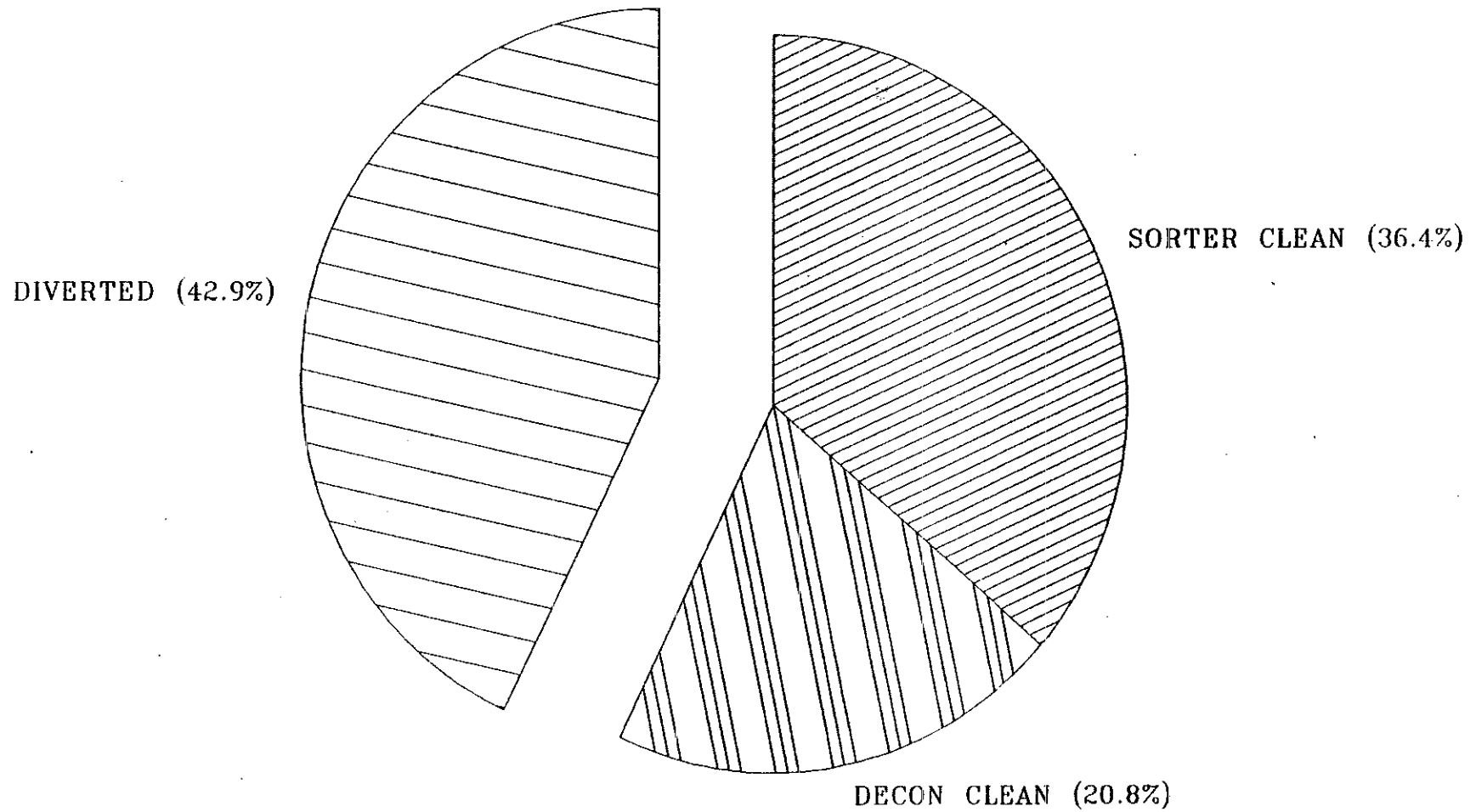
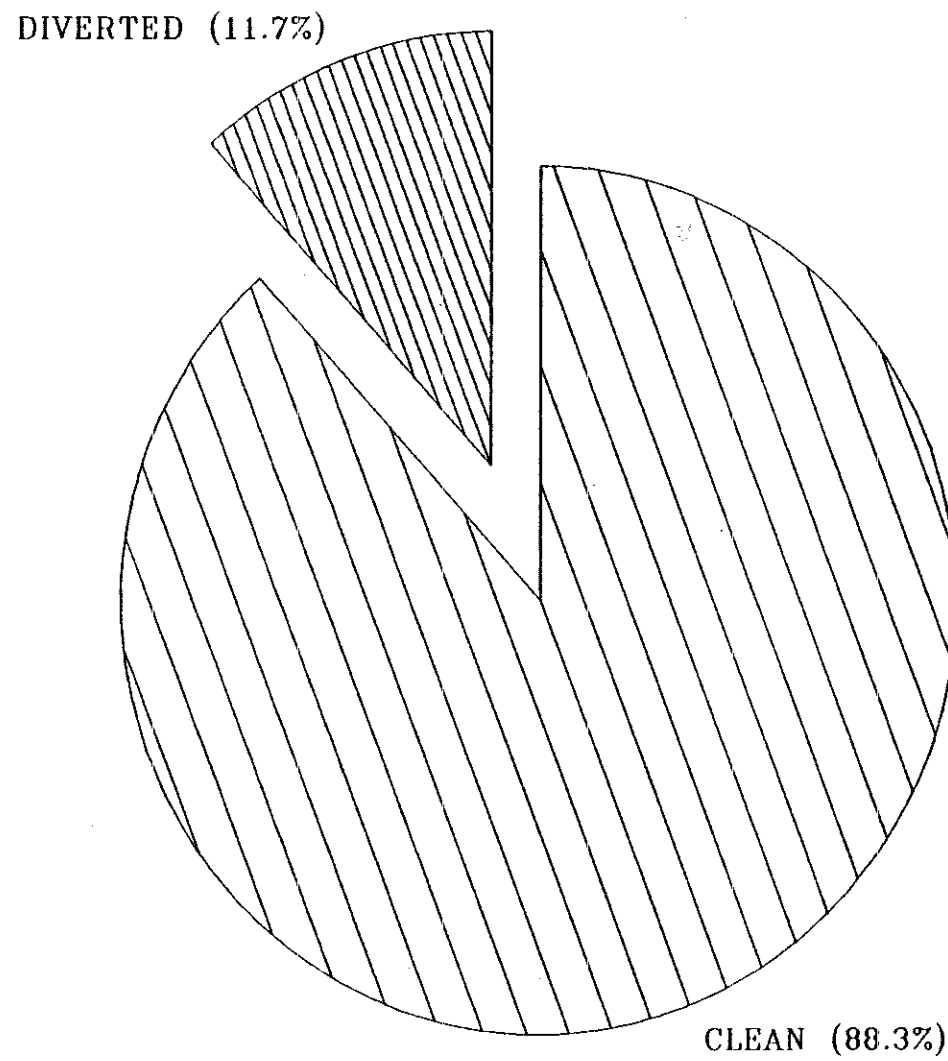


FIGURE 23 NARROW CONVEYOR TEST



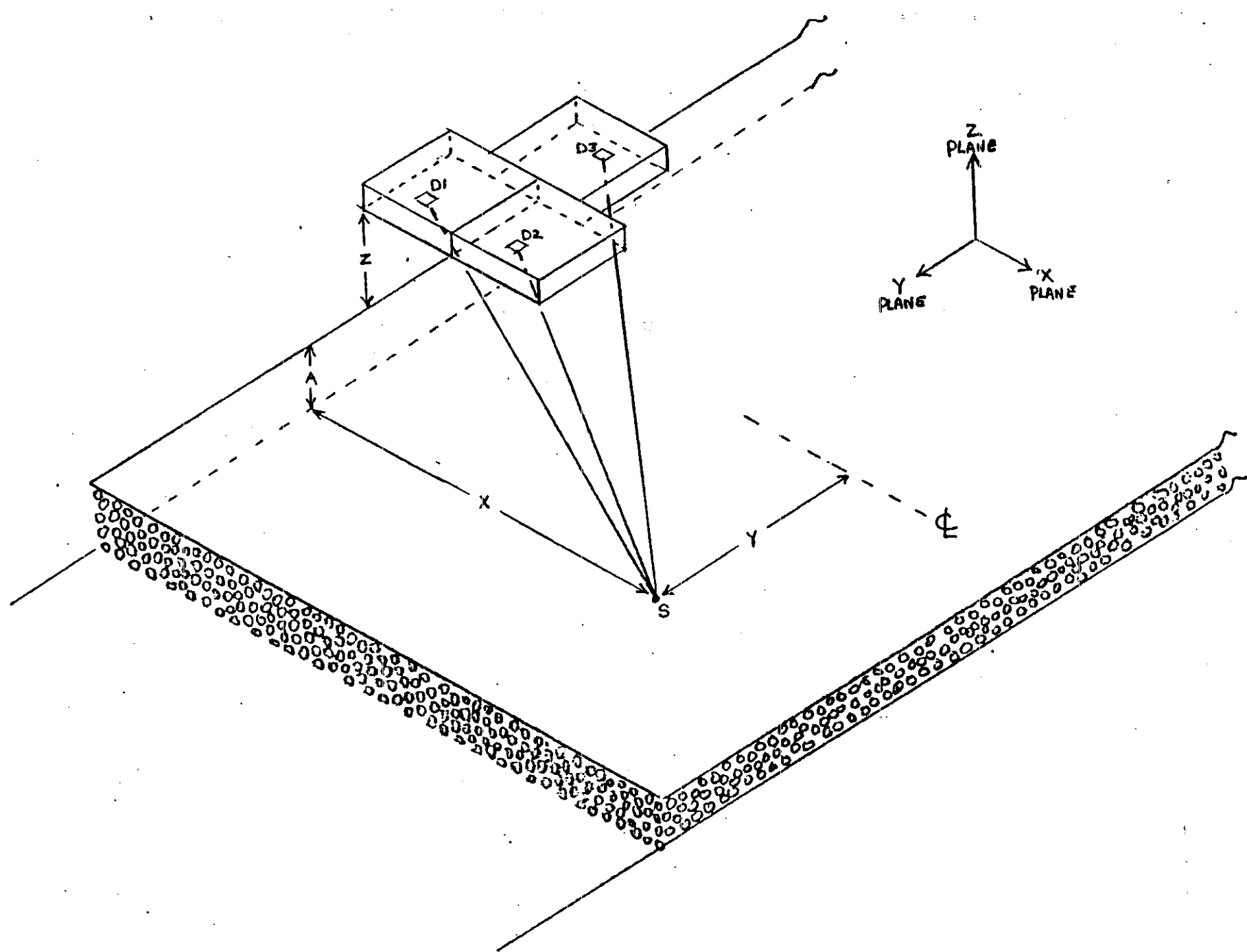


FIGURE 24 - Model for Detector Calculations

FIGURE 25 DETECTOR EFFICIENCY

(POSITION 10 - SOURCE 1.91 CM DEEP)

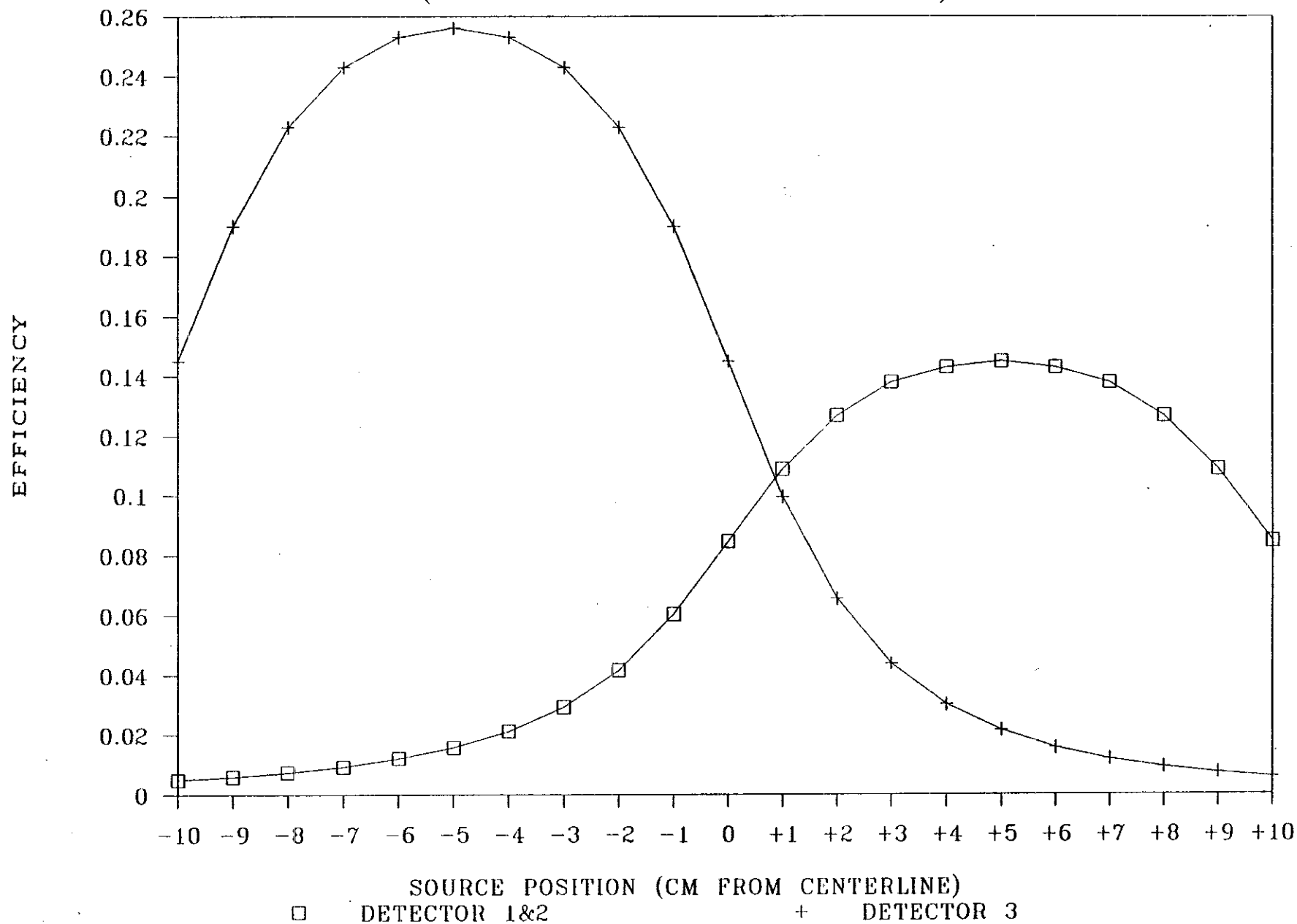


FIGURE 26 DETECTOR EFFICIENCY

POSITION 10 (SOURCE 1.91 CM DEEP)

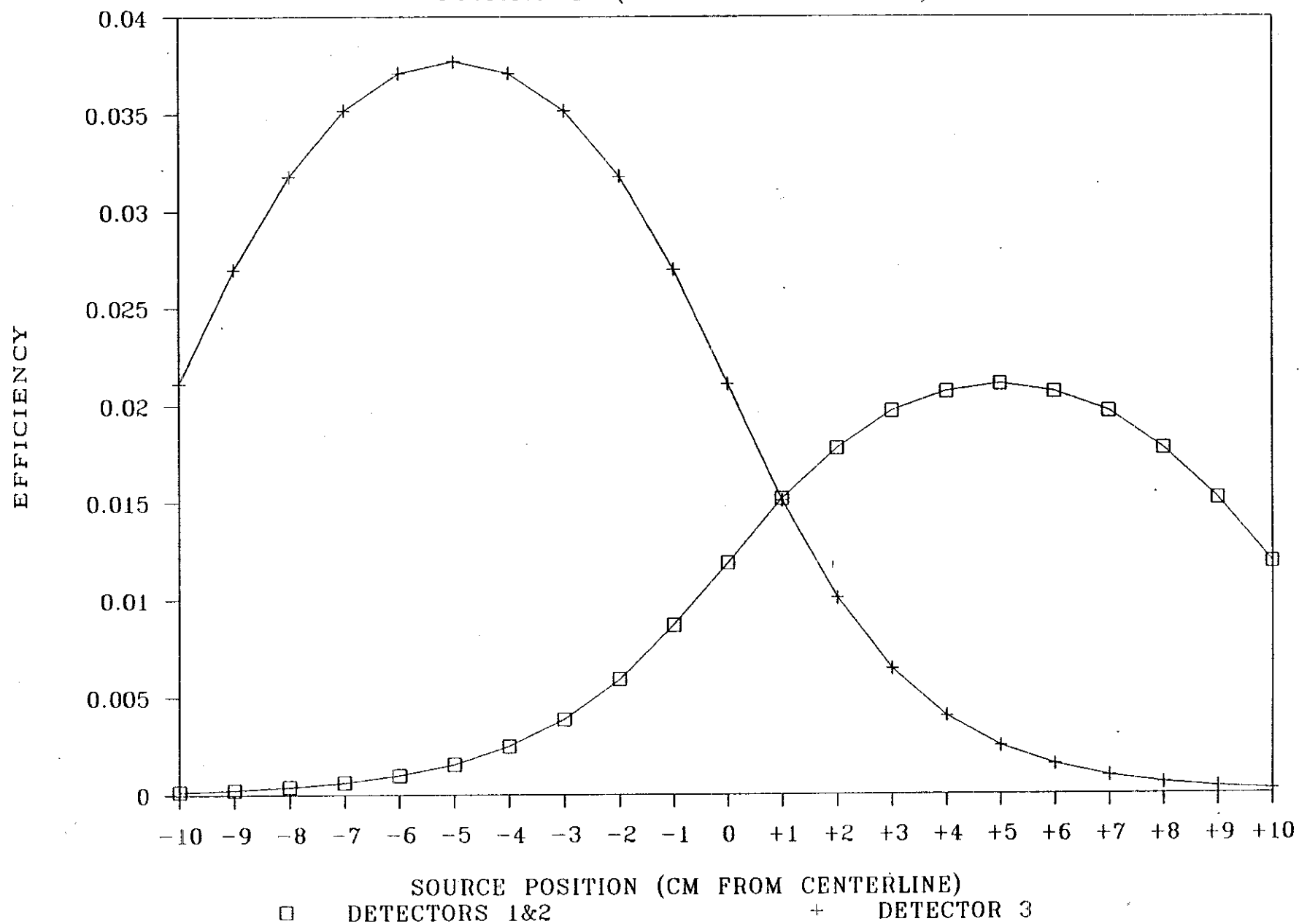


FIGURE 27 DETECTOR EFFICIENCY

POSITION 7.5 (SOURCE TOP OF SOIL)

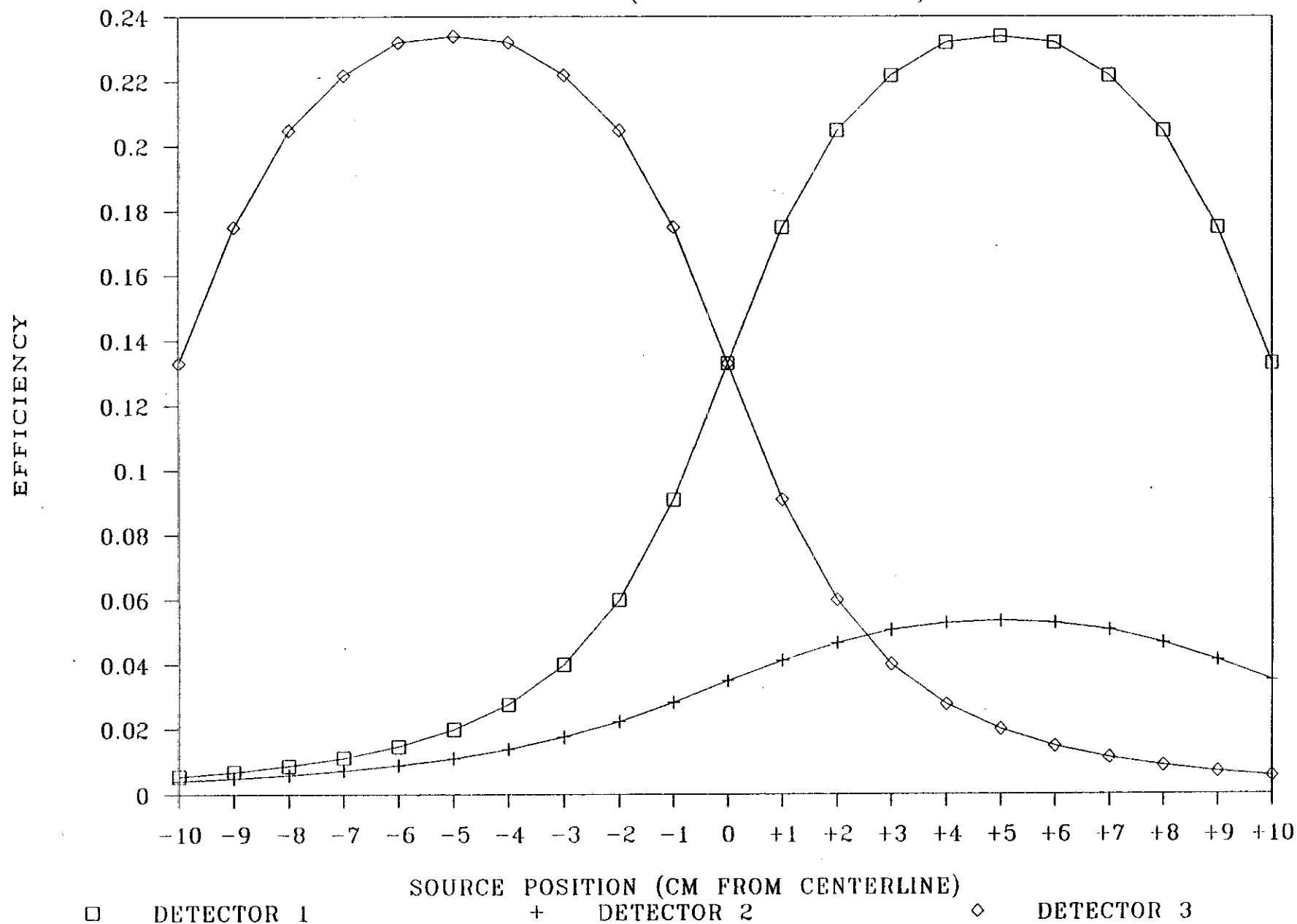


FIGURE 28 DETECTOR EFFICIENCY

POSITION 7.5 (SOURCE 1.91 CM DEEP)

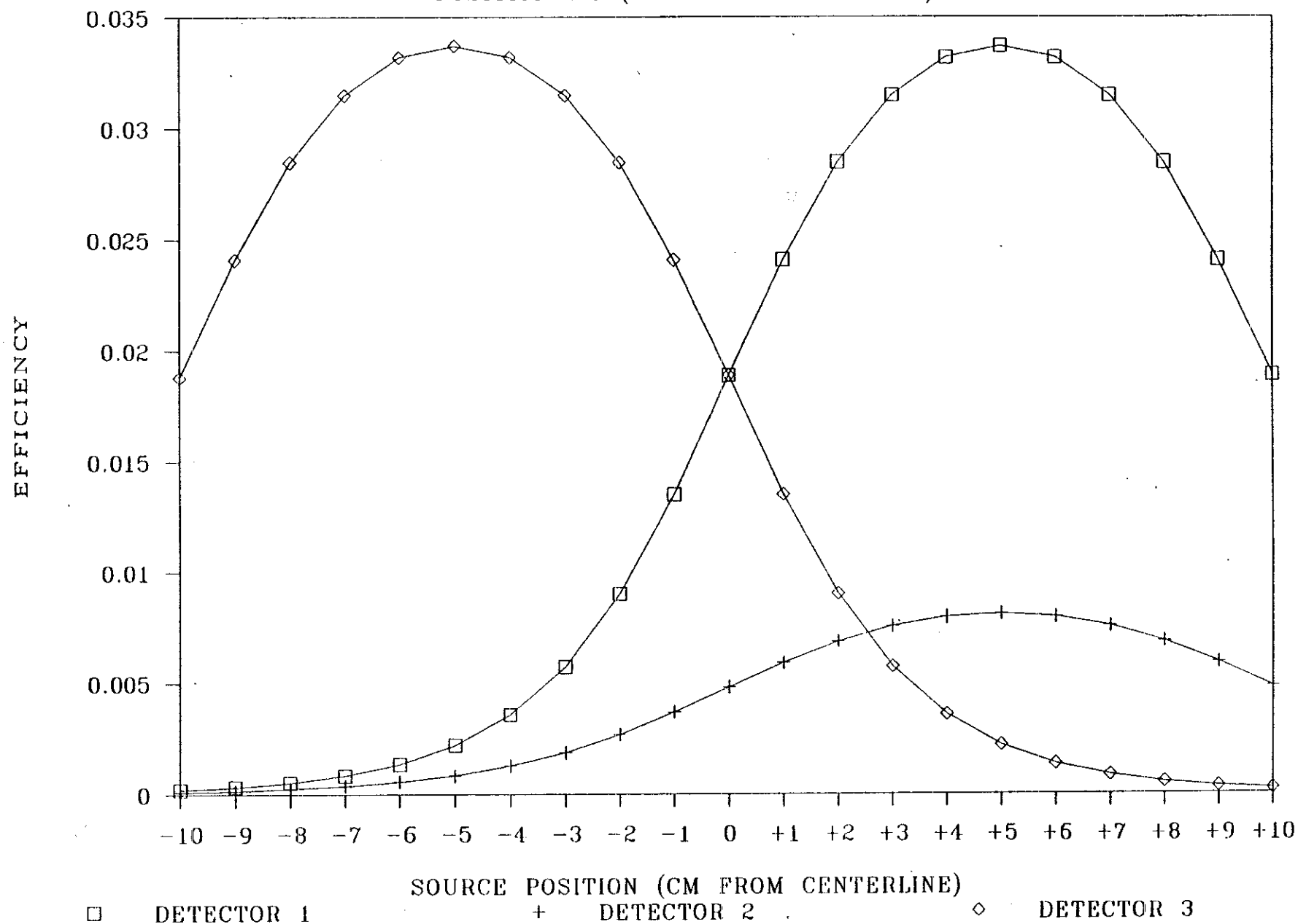


FIGURE 29 DETECTOR EFFICIENCY

POSITION 5 (SOURCE TOP OF SOIL)

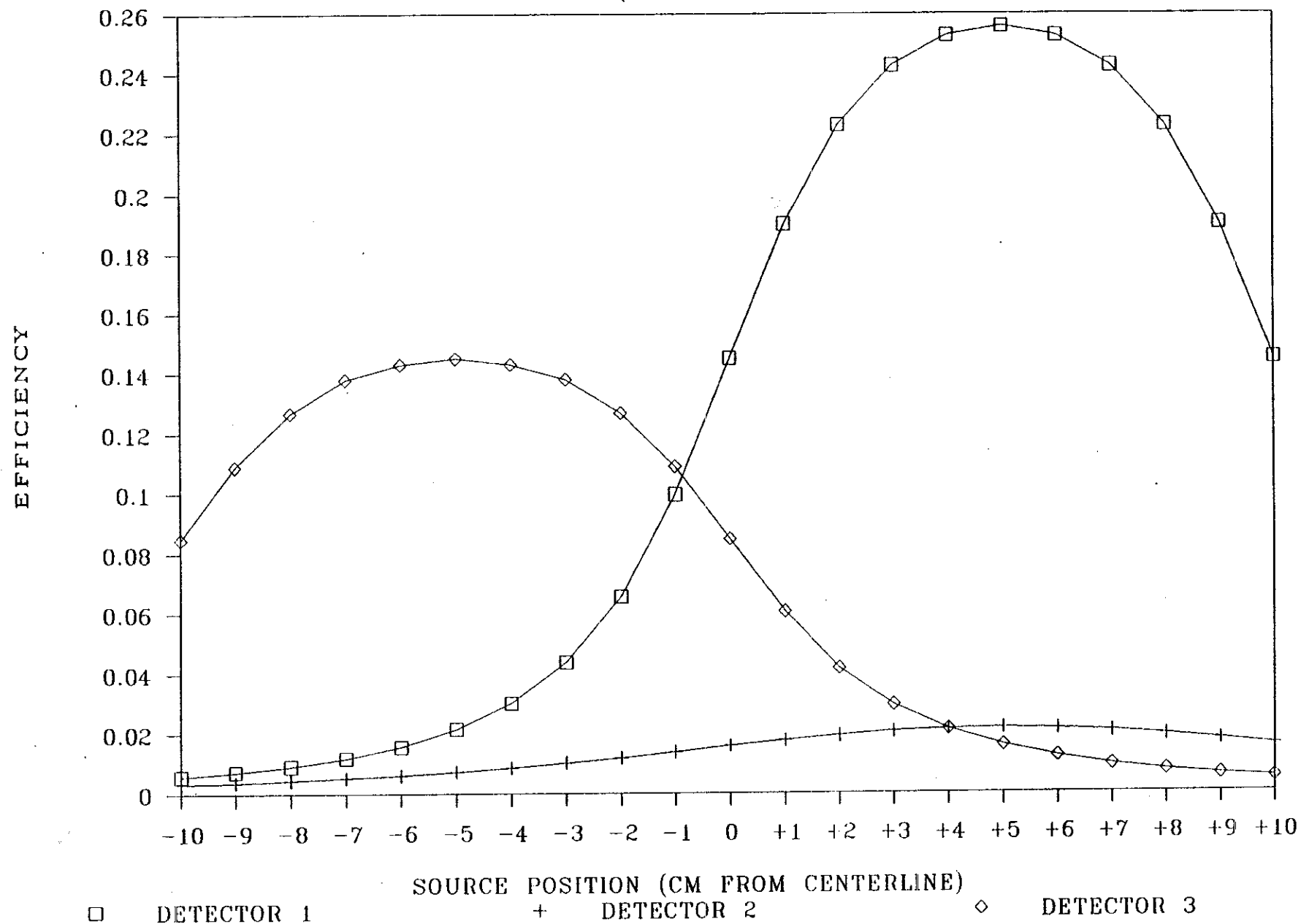


FIGURE 30 DETECTOR EFFICIENCY

POSITION 5 (SOURCE 1.91 CM DEEP)

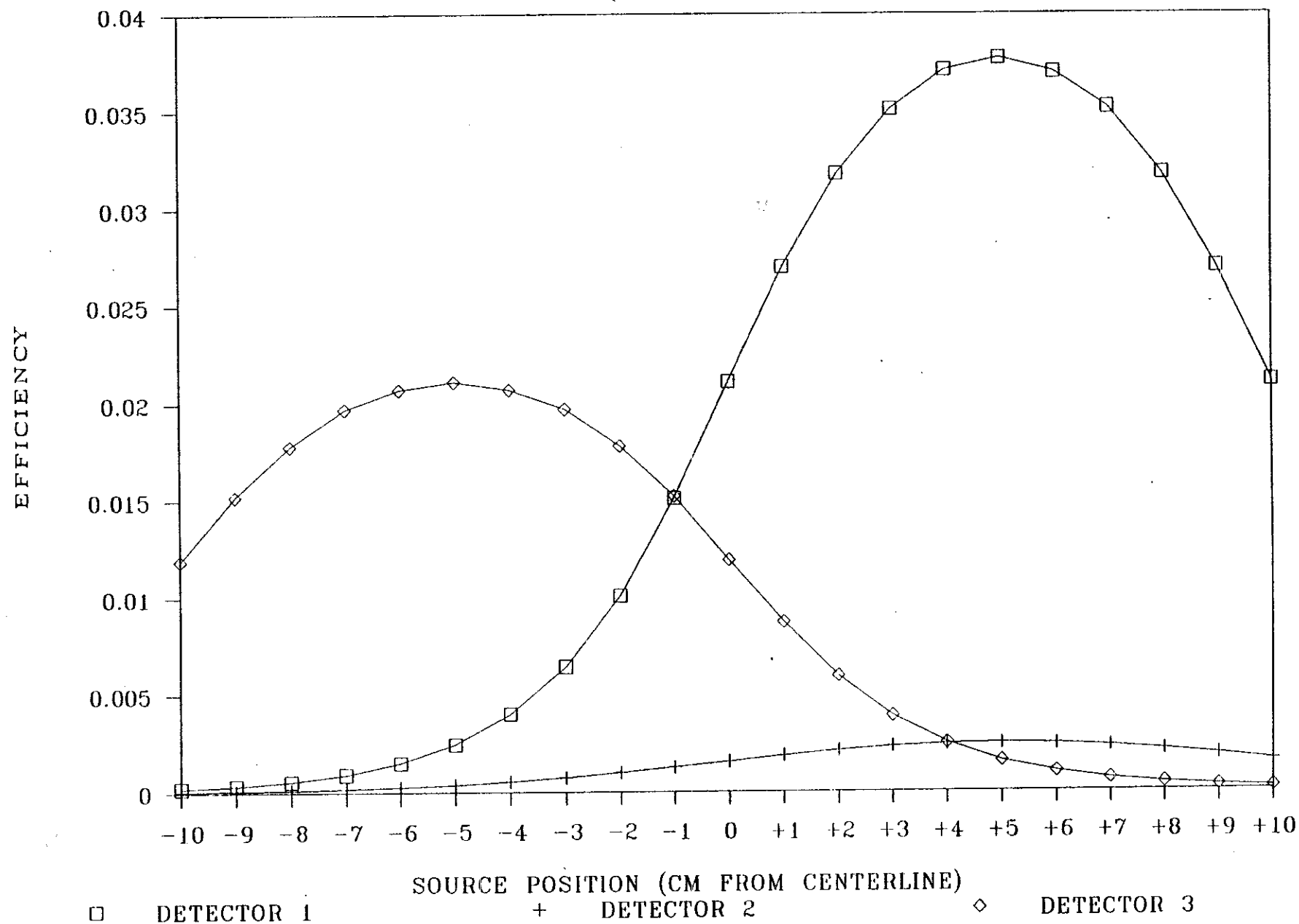


FIGURE 31 DETECTOR EFFICIENCY

POSITION 3.81 (SOURCE TOP OF SOIL)

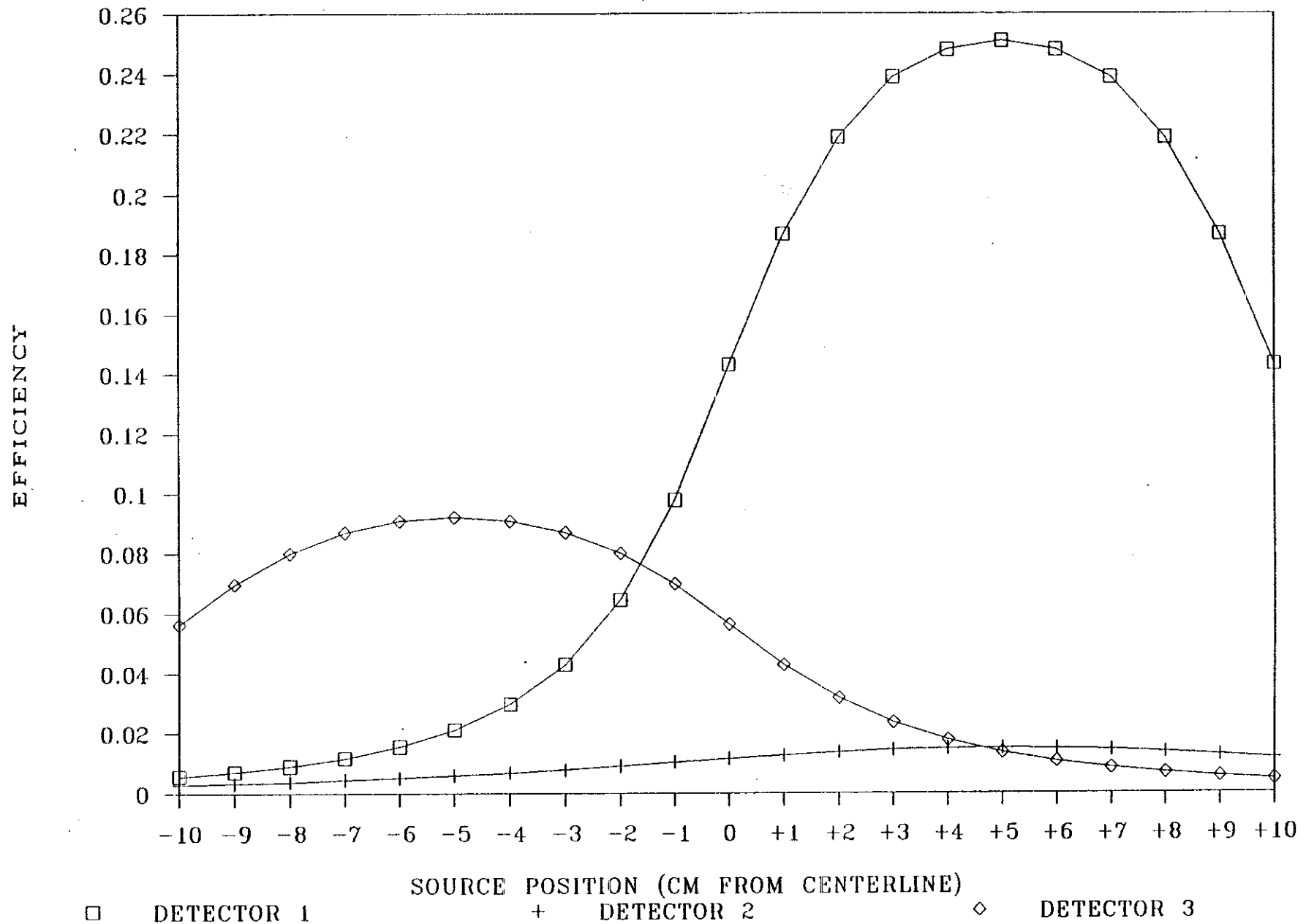


FIGURE 32 DETECTOR EFFICIENCY

POSITION 3.81 (SOURCE 1.91 CM DEEP)

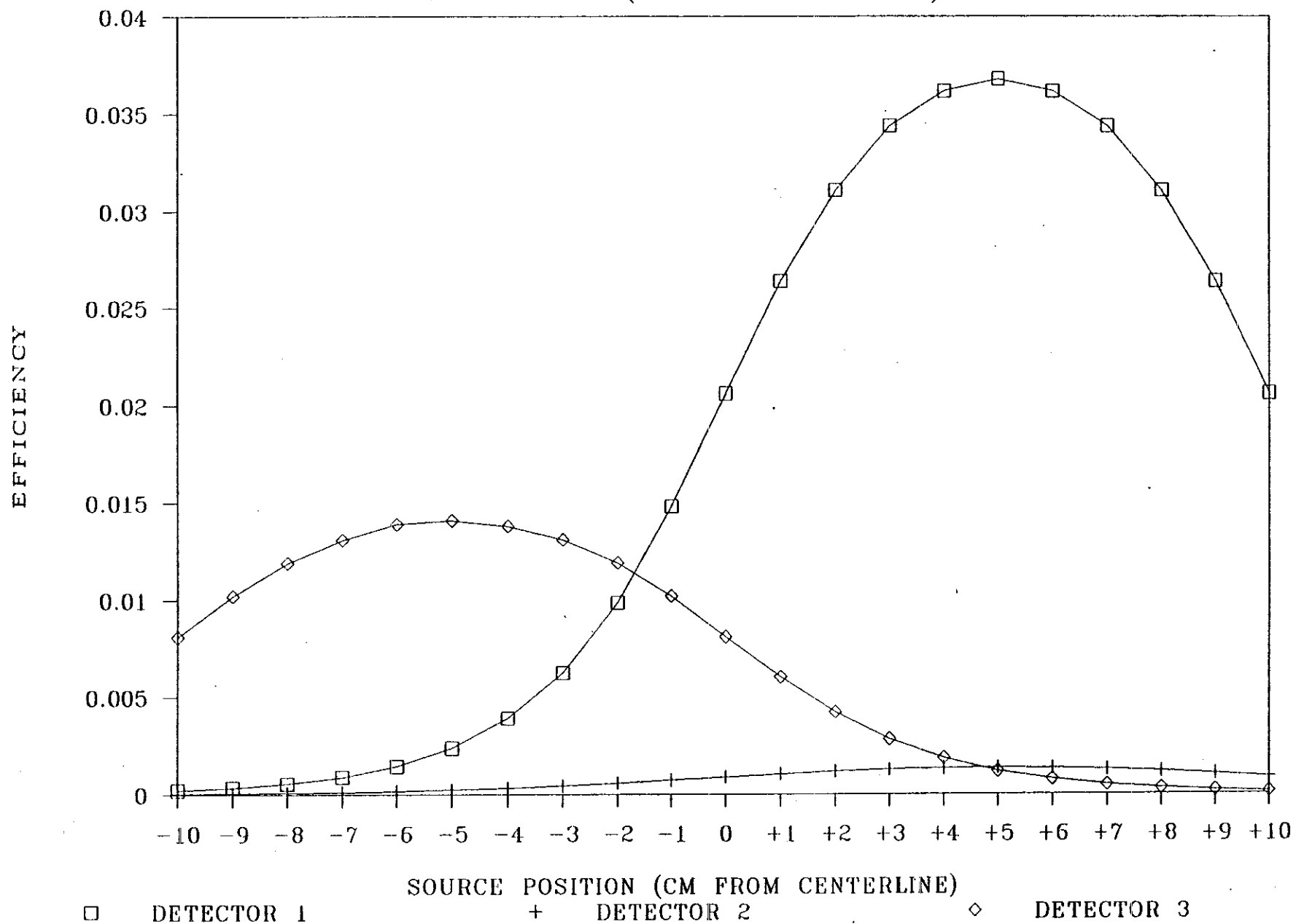


FIGURE 33 DETECTOR COUNTRATE

SOURCE 1.91 CM DEEP

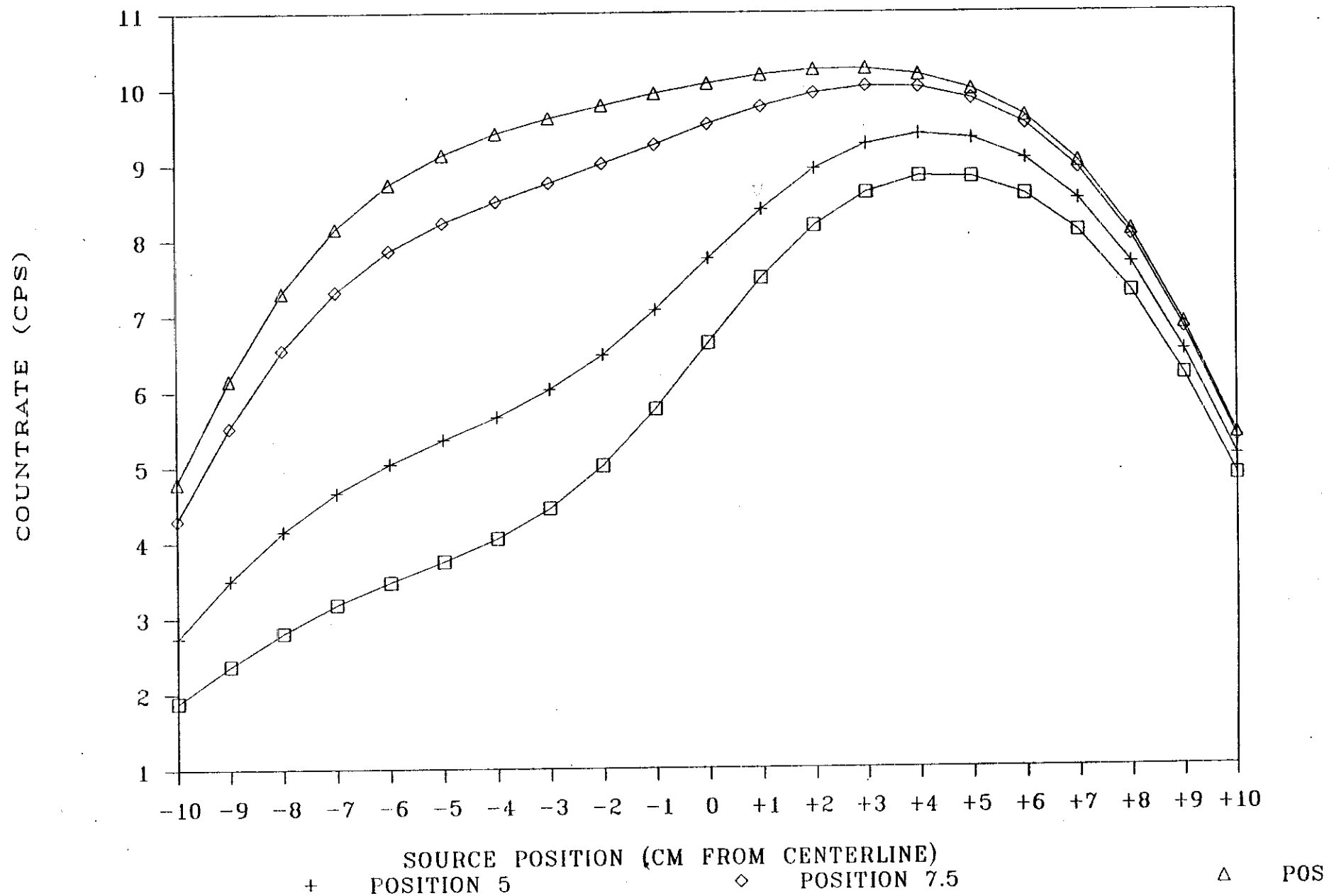


FIGURE 34 DETECTOR COUNTRATE

(SOURCE - TOP OF SOIL)

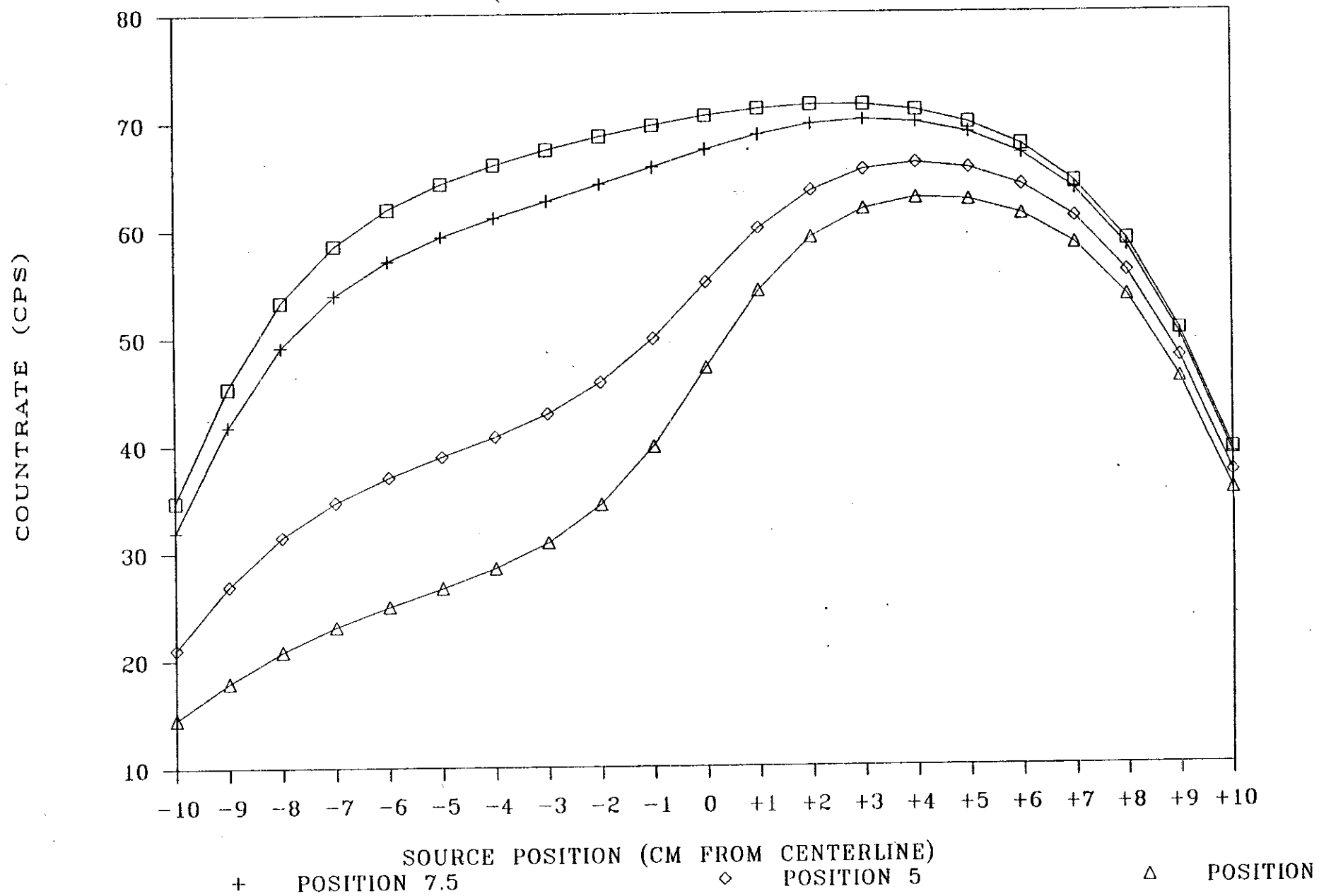


FIGURE 35 DETECTOR COUNTRATE PROFILE
(CENTERLINE ACROSS BELT)

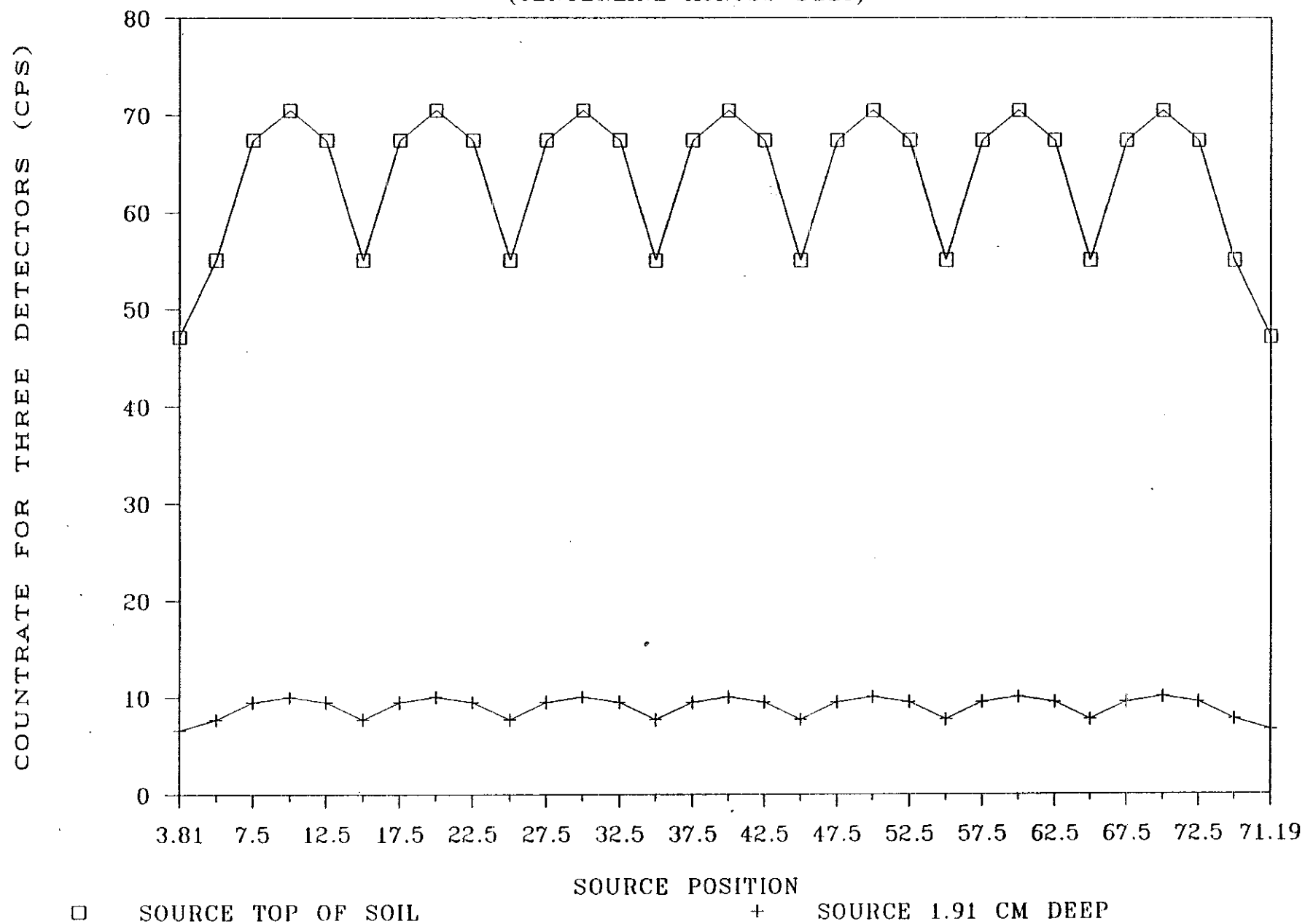
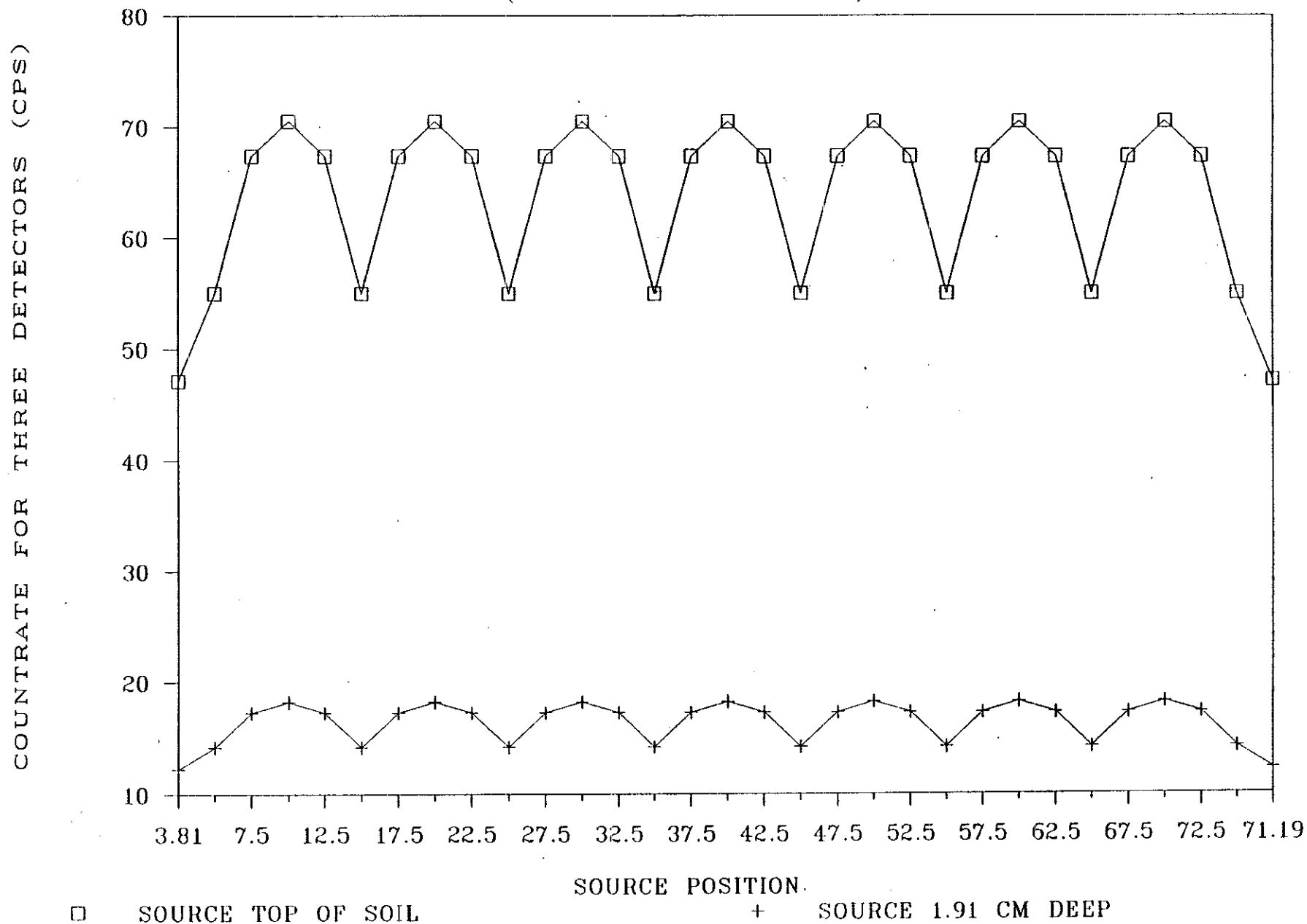


FIGURE 36. DETECTOR COUNTRATE PROFILE
(CENTERLINE ACROSS BELT)



APPENDIX II

Tables 1 - 57

TABLE 1 - SOIL SIZING STUDY GARVIN 1985

SIZE FRACTION (MM)	SAMPLE TRU 2	SAMPLE TRU 3	SAMPLE TRU 4	SAMPLE TRU 5	SAMPLE TRU 6	SAMPLE TRU 7	SAMPLE TRU 8	SAMPLE TRU 9	SAMPLE TRU 10	SAMPLE TRU 11	SAMPLE TRU 12	SAMPLE TRU 13	SAMPLE TRU 14	SAMPLE TRU 15	SAMPLE TRU 16	SAMPLE TRU 17	SAMPLE TRU 18
	WT%	WT%	WT%	WT%	WT%	WT%	WT%	WT%	WT%	WT%	WT%	WT%	WT%	WT%	WT%	WT%	WT%
+4.0	38.2	45.6	27.7	29.9	43.1	35.2	30.2	45.1	14.4	32.4	34.8	36.7	38.7	19.7	47.6	44.7	25.6
-4.0,+2.0	9.8	6.6	11.5	12.7	13.1	11.0	9.0	7.9	15.0	9.2	10.6	12.4	12.9	11.0	14.1	10.2	9.0
-2.0,+1.0	8.1	7.3	10.0	11.9	10.5	9.2	12.1	8.5	17.0	8.6	10.6	11.9	11.3	22.5	9.7	10.2	7.7
-1.0,+.5	16.2	16.1	18.5	18.7	13.1	15.6	17.1	18.3	29.4	20.5	16.7	13.6	17.7	19.7	8.6	15.8	12.2
-.5,+.25	13.8	13.2	15.4	14.2	12.4	15.0	17.6	12.8	15.7	17.3	15.9	14.7	12.9	11.6	7.6	12.1	12.8
-.25,+.125	8.1	7.5	10.0	8.2	5.2	9.8	10.1	4.9	5.9	7.6	7.6	6.8	3.2	6.9	5.4	4.7	23.7
-.125,+.062	3.3	1.8	3.1	2.2	1.3	1.7	2.0	1.2	1.3	2.2	1.5	1.7	1.6	2.9	4.9	0.9	2.6
-.062	2.4	1.8	3.8	2.2	1.3	2.3	2.0	1.2	1.3	2.2	2.3	2.3	1.6	5.8	2.2	1.4	6.4
TOTAL	99.9	99.9	100.0	100.0	100.0	99.8	100.1	99.9	100.0	100.0	100.0	100.1	99.9	100.1	100.1	100.0	100.0

TABLE 1 - SOIL SIZING STUDY GARVIN 1985

SIZE FRACTION (MM.)	SAMPLE TRU 19 WTX	SAMPLE TRU 20 WTX	SAMPLE TRU 21 WTX	SAMPLE TRU 22 WTX	SAMPLE TRU 23 WTX	SAMPLE TRU 24 WTX	SAMPLE TRU 25 WTX	SAMPLE TRU 26 WTX	SAMPLE TRU 27 WTX	SAMPLE TRU 28 WTX	SAMPLE TRU 29 WTX	SAMPLE TRU 30 WTX	SAMPLE TRU 31 WTX	MINIMUM	MAXIMUM	AVERAGE
+4.0	44.4	45.0	14.7	30.5	45.9	46.4	47.9	8.2	13.7	11.9	14.2	23.9	21.7	8.2	47.9	31.9
-4.0,+2.0	12.7	11.0	10.0	10.7	9.0	8.4	11.7	11.3	6.6	10.7	14.2	9.0	8.0	6.6	15.0	10.6
-2.0,+1.0	10.6	9.0	9.5	10.7	8.3	7.6	8.6	12.3	8.5	14.3	14.2	10.4	14.5	7.3	22.5	10.9
-1.0,+.5	13.8	16.0	17.5	14.4	11.3	11.8	11.0	18.5	17.5	17.3	18.4	17.9	14.5	8.6	29.4	16.3
-.5,+ .25	11.6	12.5	20.9	13.9	12.0	11.8	9.8	19.0	21.2	15.5	16.5	17.9	17.4	7.6	21.2	14.5
-.25,+ .125	4.8	4.5	14.2	17.1	7.9	7.6	6.1	14.4	15.1	10.7	11.3	11.9	13.0	3.2	23.7	9.1
-.125,+ .062	1.1	1.0	6.6	1.1	2.6	3.8	2.4	8.2	11.8	7.1	4.7	3.0	5.1	0.9	11.8	3.2
-.062	1.1	1.0	6.6	1.6	3.0	2.7	2.4	8.2	5.7	12.5	6.6	6.0	5.8	1.0	12.5	3.5
TOTAL	100.1	100.0	100.0	100.0	100.0	100.1	99.9	100.1	100.1	100.0	100.1	100.0	100.0			100.0

TABLE 2 - SOIL SIZING DATA KOCHEN 1985

[illegible]

TABLE 3 RADIOACTIVITY IN SOIL SIZE FRACTIONS KOCHEN 1985

SIZE FRACTION (MM)	SAMPLE 1			SAMPLE 2			SAMPLE 3			SAMPLE 4		
	NCI	BQ	GRAMS	BQ/KG	NCI	BQ	GRAMS	BQ/KG	NCI	BQ	GRAMS	BQ/KG
+4.0	0.00E+00	0.00E+00	3.81E+01	0.00E+00	3.60E-01	1.33E+01	3.36E+01	3.96E+02	1.20E+00	4.44E+01	1.12E+02	3.98E+02
-4.0,+2.0	0.00E+00	0.00E+00	7.70E+00	0.00E+00	6.00E-02	2.22E+00	7.10E+00	3.13E+02	6.00E-01	2.22E+01	3.66E+01	6.07E+02
-2.0,+1.0	4.87E+03	1.80E+05	3.60E+00	5.00E+07	1.20E-01	4.44E+00	6.80E+00	6.53E+02	1.20E+00	4.44E+01	3.80E+01	1.17E+03
-1.0,+.5	0.00E+00	0.00E+00	4.20E+00	0.00E+00	1.28E+03	4.75E+04	9.60E+00	4.95E+06	2.02E+02	7.48E+03	5.70E+01	1.31E+05
-.5,+.25	0.00E+00	0.00E+00	4.80E+00	0.00E+00	5.88E+00	2.18E+02	1.14E+01	1.91E+04	4.41E+02	1.63E+04	5.03E+01	3.24E+05
-.25,+.125	0.00E+00	0.00E+00	4.30E+00	0.00E+00	4.30E-01	1.59E+01	1.00E+01	1.59E+03	2.26E+02	8.37E+03	3.66E+01	2.29E+05
-.125,+.063	1.80E-01	6.66E+00	3.90E+00	1.71E+03	4.00E-01	1.48E+01	4.10E+00	3.61E+03	2.04E+01	7.55E+02	2.44E+01	3.09E+04
-.063	1.20E+00	4.44E+01	4.20E+00	1.06E+04	1.14E+00	4.22E+01	3.50E+00	1.21E+04	1.62E+01	5.99E+02	3.08E+01	1.95E+04

SIZE FRACTION (MM)	SAMPLE 5			SAMPLE 6			SAMPLE 7			SAMPLE 8		
	NCI	BQ	GRAMS	BQ/KG	NCI	BQ	GRAMS	BQ/KG	NCI	BQ	GRAMS	BQ/KG
+4.0	5.28E+00	1.95E+02	3.06E+01	6.38E+03	9.60E+00	3.55E+02	2.30E+02	1.55E+03	2.52E+01	9.32E+02	6.16E+01	1.51E+04
-4.0,+2.0	5.22E+00	1.93E+02	7.60E+00	2.54E+04	3.00E+01	1.11E+03	1.84E+01	6.03E+04	3.60E+01	1.33E+03	2.48E+01	5.37E+04
-2.0,+1.0	5.88E+00	2.18E+02	4.60E+00	4.73E+04	1.44E+01	5.33E+02	1.76E+01	3.03E+04	4.50E+01	1.67E+03	2.95E+01	5.64E+04
-1.0,+.5	1.20E+00	4.44E+01	2.00E-01	2.22E+05	5.40E+01	2.00E+03	2.46E+01	8.12E+04	1.04E+02	3.86E+03	3.06E+01	1.26E+05
-.5,+.25	1.50E+01	5.55E+02	5.60E+00	9.91E+04	1.47E+03	5.44E+04	2.67E+01	2.04E+06	7.56E+01	2.80E+03	3.28E+01	8.53E+04
-.25,+.125	1.44E+01	5.33E+02	5.60E+00	9.51E+04	1.81E+02	6.68E+03	2.29E+01	2.92E+05	1.67E+02	6.19E+03	2.16E+01	2.87E+05
-.125,+.063	1.05E+02	3.89E+03	6.50E+00	5.98E+05	1.49E+02	5.51E+03	1.25E+01	4.40E+05	1.62E+02	5.99E+03	1.21E+01	4.95E+05
-.063	3.42E+01	1.27E+03	1.60E+00	7.91E+05	4.74E+01	1.75E+03	1.53E+01	1.15E+05	6.72E+01	2.49E+03	1.16E+01	2.14E+05

SIZE FRACTION (MM)	SAMPLE 9			SAMPLE 10			MAXIMUM OBSERVED PU		ACTIVITY OF PURE PU (BQ)
	NCI	BQ	GRAMS	BQ/KG	NCI	BQ	GRAMS	BQ/KG	
+4.0	7.20E+00	2.66E+02	6.17E+01	4.32E+03	9.60E+00	3.55E+02	5.85E+01	6.07E+03	2.42E+03
-4.0,+2.0	1.32E+01	4.88E+02	1.41E+01	3.46E+04	6.00E-01	2.22E+01	3.00E+00	7.40E+03	1.33E+03
-2.0,+1.0	5.94E+01	2.20E+03	1.94E+01	1.13E+05	5.50E+02	2.03E+04	3.49E+01	5.83E+05	1.80E+05
-1.0,+.5	9.96E+01	3.69E+03	2.62E+01	1.41E+05	3.12E+03	1.15E+05	2.19E+01	5.27E+06	1.15E+05
-.5,+.25	1.45E+02	5.37E+03	2.03E+01	2.65E+05	5.06E+02	1.87E+04	2.38E+01	7.87E+05	5.44E+04
-.25,+.125	2.60E+02	9.63E+03	1.49E+01	6.47E+05	1.09E+03	4.05E+04	1.39E+01	2.91E+06	4.05E+04
-.125,+.063	3.26E+02	1.21E+04	7.50E+00	1.61E+06	1.60E+02	5.93E+03	4.00E+00	1.48E+06	1.21E+04
-.063	9.18E+01	3.40E+03	4.80E+00	7.08E+05	3.30E+02	1.22E+04	1.11E+01	1.10E+06	1.22E+04

TABLE 4 - PARTICLE SIZING STUDY - APRIL 1988

SAMPLE	PARAMETER	SOIL SIZE (CM)										
		+5.08	-5.08, +3.81	-3.81, +2.54	-2.54, +1.91	-1.91, +1.27	-1.27, +1.11	-1.11, +0.95	-0.95, +0.79	-0.79, +0.64	-0.64, +0.47	
CLEAN 1	WEIGHT (GRAMS)	2355	483	918	495	1175	473	482	482	747	893	13309
	ACTIVITY (CPM/MG)	0	0	0	0	0	0	0	0	0	0	0
CLEAN 2	WEIGHT (GRAMS)	1211	750	1916	1751	2415	406	866	863	1283	1401	14032
	ACTIVITY (CPM/MG)	0	0	0	0	0	0	0	0	0	0	21
CLEAN 3	WEIGHT (GRAMS)	1075	343	1162	876	2468	111	478	834	1605	2016	14862
	ACTIVITY (CPM/MG)	0	0	0	0	0	0	0	0	0	0	20
CLEAN 4	WEIGHT (GRAMS)	1248	566	658	686	833	246	423	496	496	691	6258
	ACTIVITY (CPM/MG)	0	0	0	0	0	0	0	0	0	0	0
CLEAN 5	WEIGHT (GRAMS)	838	356	795	1047	1072	190	405	441	668	820	7452
	ACTIVITY (CPM/MG)	0	0	0	0	0	0	0	0	0	0	0
CLEAN 6	WEIGHT (GRAMS)	1235	323	535	1023	1099	245	470	661	897	1027	11363
	ACTIVITY (CPM/MG)	0	0	0	0	0	0	0	0	0	0	32
CLEAN 7	WEIGHT (GRAMS)	2103	23	582	526	758	213	263	363	533	578	6318
	ACTIVITY (CPM/MG)	0	0	0	0	0	0	0	0	0	0	49
RCA 8	WEIGHT (GRAMS)	960	440	881	458	890	293	443	483	693	695	2730
	ACTIVITY (CPM/MG)	0	0	0	0	0	0	0	0	0	0	92
RCA 9	WEIGHT (GRAMS)	316	13	519	376	903	255	330	508	721	790	5555
	ACTIVITY (CPM/MG)	0	0	0	0	681	0	0	0	566	604	265
RCA 10	WEIGHT (GRAMS)	201	428	855	678	1110	338	523	681	928	956	5480
	ACTIVITY (CPM/MG)	0	0	0	0	0	0	0	0	0	0	0
RCA 11	WEIGHT (GRAMS)	408	281	911	601	1021	308	540	583	798	765	6280
	ACTIVITY (CPM/MG)	0	0	0	779	0	0	0	0	0	0	0
RCA 12	WEIGHT (GRAMS)	541	841	1135	796	1261	245	461	453	793	775	5360
	ACTIVITY (CPM/MG)	0	0	0	0	0	0	0	0	0	0	0
RCA 13	WEIGHT (GRAMS)	506	173	583	552	723	258	387	403	635	627	3963
	ACTIVITY (CPM/MG)	0	0	0	0	0	0	0	0	0	0	0
RCA 14	WEIGHT (GRAMS)	278	175	941	463	835	210	328	425	603	638	6588
	ACTIVITY (CPM/MG)	0	0	0	0	0	0	0	0	0	0	0

TABLE 4 - PARTICLE SIZING DATA - APRIL 1988

SAMPLE	PARAMETER	SOIL SIZE (CM)										
		+5.08	-5.08, +3.81	-3.81, +2.54	-2.54, +1.91	-1.91, +1.27	-1.27, +1.11	-1.11, +0.95	-0.95, +0.79	-0.79, +0.64	-0.64, +0.47	-0.47
RCA 15	WEIGHT (GRAMS)	201	0	347	242	752	196	347	357	578	658	6771
	ACTIVITY (CPM/MG)	0	0	0	0	339	0	0	0	0	0	43
RCA 16	WEIGHT (GRAMS)	548	178	383	301	835	183	301	451	623	691	6813
	ACTIVITY (CPM/MG)	0	0	0	0	0	0	0	0	0	0	0
RCA 17	WEIGHT (GRAMS)	218	306	696	613	892	195	348	353	666	575	5145
	ACTIVITY (CPM/MG)	0	0	0	0	0	0	0	0	0	0	0
RCA 18	WEIGHT (GRAMS)	337	570	1037	688	748	163	268	240	373	368	2258
	ACTIVITY (CPM/MG)	0	0	0	0	0	0	0	0	0	0	0
RCA 19	WEIGHT (GRAMS)	2258	60	718	196	687	90	222	266	427	236	2328
	ACTIVITY (CPM/MG)	0	0	0	0	0	0	0	0	0	0	0
RCA 20	WEIGHT (GRAMS)	1100	856	1351	723	822	185	404	342	439	411	1993
	ACTIVITY (CPM/MG)	0	0	0	0	0	0	0	0	0	0	0
RCA 21	WEIGHT (GRAMS)	873	87	572	455	698	163	280	275	343	349	3443
	ACTIVITY (CPM/MG)	0	0	0	0	0	0	0	0	0	0	0
RCA 22	WEIGHT (GRAMS)	1115	419	571	300	681	187	330	323	481	512	4458
	ACTIVITY (CPM/MG)	0	0	0	0	0	0	0	0	0	0	68
RCA 23	WEIGHT (GRAMS)	0	560	497	312	730	189	342	359	483	473	3755
	ACTIVITY (CPM/MG)	0	0	0	0	0	0	0	0	0	0	0
RCA 24	WEIGHT (GRAMS)	564	775	496	539	742	186	280	297	381	380	2348
	ACTIVITY (CPM/MG)	0	0	0	0	0	0	0	0	0	0	0
RCA 25	WEIGHT (GRAMS)	0	114	94	258	436	133	238	288	440	424	2878
	ACTIVITY (CPM/MG)	0	0	0	1312	0	0	0	892	0	3951	240
RCA 26	WEIGHT (GRAMS)	0	0	130	210	558	193	346	385	558	560	4279
	ACTIVITY (CPM/MG)	0	0	0	0	914	0	0	953	1059	788	1115
RCA 27	WEIGHT (GRAMS)	0	0	123	246	443	165	237	264	352	378	3215
	ACTIVITY (CPM/MG)	0	0	0	0	0	0	9743	1111	773	2030	2203
RCA 28	WEIGHT (GRAMS)	149	119	0	78	280	127	174	232	408	418	3328
	ACTIVITY (CPM/MG)	0	0	0	0	1242	0	2326	1769	829	1169	3050

TABLE 4 - PARTICLE SIZING JY - APRIL 1988

SAMPLE	PARAMETER	SOIL SIZE (CM)										
		+5.08	-5.08, +3.81	-3.81, +2.54	-2.54, +1.91	-1.91, +1.27	-1.27, +1.11	-1.11, +0.95	-0.95, +0.79	-0.79, +0.64	-0.64, +0.47	-0.47
RCA 29	WEIGHT (GRAMS)	0	178	152	226	395	156	236	294	491	521	4594
	ACTIVITY (CPM/MG)	0	0	0	1267	1694	0	1249	1315	747	2340	389
RCA 30	WEIGHT (GRAMS)	0	209	230	249	478	156	268	315	471	478	3730
	ACTIVITY (CPM/MG)	0	0	0	1536	1003	2252	1769	1970	1764	2817	5652
RCA 31	WEIGHT (GRAMS)	207	164	656	284	626	178	350	369	531	579	4766
	ACTIVITY (CPM/MG)	0	0	0	0	853	1615	1288	1165	1507	1522	2675
RCA 32	WEIGHT (GRAMS)	0	0	369	260	451	136	220	265	355	426	4133
	ACTIVITY (CPM/MG)	0	0	0	0	0	0	0	0	0	0	79
RCA 33	WEIGHT (GRAMS)	0	0	90	196	408	165	278	266	495	578	7365
	ACTIVITY (CPM/MG)	0	0	0	0	0	0	0	0	0	0	0
RCA 34	WEIGHT (GRAMS)	0	0	76	104	243	100	166	197	335	385	3701
	ACTIVITY (CPM/MG)	0	0	0	0	0	0	0	0	0	0	0
RCA 35	WEIGHT (GRAMS)	0	0	52	143	509	173	268	272	395	423	2525
	ACTIVITY (CPM/MG)	0	0	0	0	51898	4119	1060	5029	1316	7063	4567
RCA 36	WEIGHT (GRAMS)	0	0	0	0	0	571	253	244	405	418	4610
	ACTIVITY (CPM/GM)	0	0	0	0	0	0	3704	0	0	0	235
RCA 37	WEIGHT (GRAMS)	0	0	0	0	0	119	53	83	103	120	6114
	ACTIVITY (CPM/MG)	0	0	0	0	0	0	0	0	0	0	156
RCA 38	WEIGHT (GRAMS)	0	0	0	0	0	0	19	24	35	32	5410
	ACTIVITY (CPM/MG)	0	0	0	0	0	0	0	0	0	0	263
NUMBER OF POSITIVE RESULTS IN SIZE FRACTION		0	0	0	4	8	3	7	8	8	9	15

Table 5 PLANT OPERATION ANALYSIS

DATE	VOLUME PROCESSED (YDS)	PLANT OPERATION (HRS)	WORK DAY (HRS)	DOWN TIME (HRS)	DOWN TIME ROUTINE?	COMMENTS
2/25/89	70.4	6.0	9.0	3.0	YES	FRONT END LOADER DOWN
2/27/89	5.1	1.0	9.0	8.0	NO	PLUGGED CRUSHER & SCREEN
2/28/89	19.4	4.0	11.0	7.0	NO	PLUGGED CRUSHER & SCREEN
3/1/89	65.0	5.0	9.0	4.0	NO	CLEAN SCREEN
3/2/89	84.5	7.0	9.0	2.0	NO	CLEAN SCREEN
3/3/89	99.4	9.0	10.5	1.5	YES	CONDUIT IN SCREEN
3/4/89	80.9	7.0	9.0	2.0	NO	CLEAN SCREEN
3/6/89	67.5	5.5	9.0	3.5	YES	ROUTINE MAINTENANCE
3/7/89	110.9	7.5	9.0	1.5	YES	NORMAL RUN
3/8/89	107.0	7.5	9.0	1.5	YES	NORMAL RUN
3/9/89	69.7	5.5	9.0	3.5	YES	FRONT END LOADER DOWN
3/10/89	33.2	3.0	9.0	6.0	NO	INSTALL NEW SCREEN
3/11/89	44.4	5.5	9.0	3.5	NO	RERUN DIVERTED MATERIAL
3/13/89	73.4	6.5	9.0	2.5	NO	RERUN DIVERTED MATERIAL
3/14/89	46.4	3.0	11.0	8.0	NO	CLEAN SOIL & RERUN CONCENTRATE
3/15/89	119.4	8.0	9.0	1.0	YES	NORMAL RUN
3/16/89	111.0	8.0	9.0	1.0	YES	NORMAL RUN
TOTAL	1207.6	99.0	158.5	59.5		

TABLE 6 - MATERIAL BALANCE (1043 YDS)

DATE 1989	PLANT FEED (CUYD)	OVERSIZE (CUYD)	SORTER CLEAN (CUYD)	TO DECON (CUYD)	DECON FEED (CUYD)	DECON CLEAN (CUYD)	DECON DIVERTED (CUYD)	CONC. (CUYD)	POND (CUYD)
2/25	70.40	5.60	41.42	23.38	3.18	2.33	0.36	0.18	0.31
2/27	5.10	0.10	1.46	3.54	21.59	15.77	2.90	0.83	2.09
2/28	19.40	4.10	10.08	5.22	0.00	0.00	0.00	0.00	
3/1	65.00	4.20	33.62	27.18	29.13	17.82	7.42	1.07	2.82
3/2	84.50	4.80	51.45	28.25	19.83	12.67	4.41	0.83	1.92
3/3	99.40	7.40	50.38	41.62	27.26	17.43	6.21	0.98	2.64
3/4	80.90	6.80	43.90	30.20	23.64	16.03	4.43	0.89	2.29
3/6	67.50	7.50	33.44	26.56	26.13	18.87	3.99	0.74	2.53
3/7	110.90	8.10	76.41	26.39	41.79	29.47	6.58	1.70	4.04
3/8	107.00	11.40	71.07	24.53	30.6	21.02	5.58	1.04	2.96
3/9	69.70	11.40	37.31	20.99	28.06	19.40	5.32	0.62	2.72
3/10	33.20	4.50	12.14	16.56	13.39	10.05	1.62	0.42	1.30
3/11	0.00	0.00	0.00	0.00	13.2	9.76	1.89	0.27	1.28
3/15	119.40	14.40	63.29	41.71	38.85	25.01	9.16	0.92	3.76
3/16	111.00	6.00	66.83	38.17	31.78	21.19	6.80	0.71	3.08
3/17	0.00	0.00	0.00	0.00	5.89	4.53	0.37	0.42	0.57
TOTAL	1043.4	96.3	592.8	354.3	354.32	241.35	67.04	11.62	34.31

TABLE 7 PROJECTED MATERIAL BALANCE

MATERIAL BALANCE POINT	VOLUME (CU YD)
FEED	1043.40
SORTER CLEAN	592.80
CONCENTRATE	11.62
DECON CLEAN	241.35
OVERSIZE CONTAMINATED	5.97
OVERSIZE CLEAN	90.33
POND	34.31
DIVERTED CLEAN	59.66
DIVERTED CONTAMINATED	7.37

TABLE 8 - PILOT PLANT PARTICLE TEST RUNS

RUN	VOLUME (CUYD)	PARTICLES DETECTED	TOTAL ACTIVITY (UCI)	PARTICLES PER CUYD	ACTIVITY PER YARD (UCI)	DIVERTED PARTICLES	DIVERTED ACTIVITY (UCI)	DIVERTED PARTICLES PER CUYD	DIVERTED ACTIVITY (UCI/CUYD)
A	1.215	220	23.3	181.07	19.18	55	2.34	45.27	1.93
B	3.26	451	49.6	138.34	15.21	140	3.02	42.94	0.93
C	2.68	368	27.3	137.31	10.19	160	4.16	59.70	1.55

TABLE 9 - PRODUCTION PLANT PARTICLE ESTIMATES

DATE 1989	NUMBER OF PARTICLE DIVERSION SORTER	VOLUME TO DECON PLANT (CUYD)	DIVERSIONS PER CU YD	PROJECTED PARTICLES PER CU YD	DECON DIVERSIONS PER CU YD
2/25	1056	23.38	45.17	117.89	28.24
2/27	63	3.54	17.80	46.45	15.30
2/28	755	5.22	144.64	377.50	0
3/1	557	27.18	20.49	53.49	25.75
3/2	1680	28.25	59.47	155.21	25.68
3/3	1600	41.62	38.44	100.34	24.16
3/4	1517	30.20	50.23	131.10	19.21
3/6	1414	26.57	53.22	138.90	12.49
3/7	1539	26.39	58.32	152.21	12.58
3/8	ND	24.53	ND	ND	23.28
3/9	1227	20.99	58.46	152.57	20.96
3/10	1072	16.56	64.73	168.96	17.92
3/11	1641	40.50	40.52	105.75	23.46
3/13	1704	51.00	33.41	87.20	24.32
3/14	712	6.91	103.04	103.40	27.37
3/15	2695	41.71	64.61	168.64	24.83
3/16	2647	38.17	69.35	181.00	27.57
3/17	0	0	0.00	0	23.97

ND - NO DATA AVAILABLE

TABLE 10 - CONCENTRATE ACTIVITY AND DIVERSION RATES

DATE	CONCENTRATE WEIGHT (KG)	CONCENTRATE ACTIVITY (UCI)	CONCENTRATE ACTIVITY (NCI/GM)	DECON FEED (CUYD)	CONCENTRATE ACTIVITY (UCI/CUYD)	PARTICLES DIVERTED DECON PLANT	PARTICLES DIVERTED PER CUYD
1989							
2/16	575	217	0.38	19	11.42	470	24.74
2/17	985	273	0.28	11.3	24.16	224	19.82
2/18	2379	734	0.31	14.2	51.69	375	26.41
2/20	2136	289	0.14	19.6	14.74	311	15.87
2/21	1886	268	0.14	14.9	17.99	189	12.68
2/22	2464	243	0.10	22.2	10.95	460	20.72
2/23	1640	330	0.20	26.4	12.50	373	14.13
2/24	2218	552	0.25	36.4	15.16	618	16.98
2/25	328	45	0.14	3.4	13.24	96	28.24
2/27	1312	326	0.25	23.2	14.05	355	15.30
3/1	1640	751	0.46	31.3	23.99	806	25.75
3/2	1312	614	0.47	21.3	28.83	547	25.68
3/3	1476	617	0.42	29.3	21.06	708	24.16
3/4	1394	547	0.39	25.4	21.54	488	19.21
3/6	1025	563	0.55	28.1	20.04	351	12.49
3/7	2505	546	0.22	44.9	12.16	565	12.58
3/8	1558	277	0.18	32.9	8.42	766	23.28
3/9	984	356	0.36	30.2	11.79	633	20.96
3/10	615	240	0.39	14.4	16.67	258	17.92
3/11	451	104	0.23	14.2	7.32	233	16.41
3/11R	902	386	0.43	23.7	16.29	556	23.46
3/13R	1890	558	0.30	47.9	11.65	1165	24.32
3/14R	1303	377	0.29	28.9	13.04	791	27.37
3/15	1357	720	0.53	41.80	17.22	1038	24.83
3/16	1066	602	0.56	34.2	17.60	943	27.57
3/17	533	223	0.42	6.3	35.40	151	23.97
=====							
	35934	10758.00		645.40		13470.00	544.86

TABLE 11 CONCENTRATE ASSAY DATA

CONTAINER NUMBER	ACTIVITY UCI	CONCENTRATION NCI/GM
1	490	0.28
2	147	0.13
3	230	0.16
4	164	0.13
5	235	0.17
6	196	0.13
7	117	0.08
8	289	0.21
9	266	0.19
10	360	0.28
11	337	0.24
12	523	0.38
13	827	0.55
14	565	0.40
15	555	0.38
16	655	0.52
17	289	0.19
18	358	0.25
19	274	0.21
20	500	0.37
21	492	0.37
22	471	0.31
23	429	0.28
24	1288	1.06
25	719	0.51
26	821	0.49
27	177	1.23

TABLE 12 DAILY CONCENTRATE AND DIVERSION DATA

DATE	FEED CU YD	CONCENTRATE CU YD	DIVERTED CU YD	% OF FEED TO CONCENTRATE	% OF FEED DIVERTED
2/16	19.0	0.47	5.3	2.47	27.89
2/17	11.3	0.63	2.4	5.58	21.24
2/18	14.2	1.84	4.8	12.96	33.80
2/20	19.6	1.57	2.7	8.01	13.78
2/21	14.9	1.25	1.1	8.39	7.38
2/22	22.2	1.40	3.4	6.31	15.32
2/23	26.4	1.07	2.9	4.05	10.98
2/24	36.4	1.45	10.9	3.98	29.95
2/25	3.4	0.18	0.4	5.29	11.47
2/27	23.2	0.83	3.2	3.58	13.58
3/1	31.3	1.07	8.1	3.42	25.75
3/2	21.3	0.83	4.8	3.90	22.49
3/3	29.3	0.98	6.8	3.34	23.04
3/4	25.4	0.89	4.8	3.50	18.94
3/6	28.1	0.74	4.3	2.63	15.41
3/7	44.9	1.70	7.2	3.79	15.92
3/8	32.9	1.04	6.1	3.16	18.42
3/9	30.2	0.62	5.8	2.05	19.14
3/10	14.4	0.42	1.8	2.92	12.22
3/11	14.2	0.27	2.1	1.90	14.44
3/11R	23.7	0.65	15.5	2.74	65.40
3/13R	47.9	1.25	31.3	2.61	65.34
3/14R	28.9	0.89	13.0	3.08	44.98
3/15	41.8	0.92	9.2	2.20	21.91
3/16	34.2	0.71	6.8	2.08	19.88
3/17	6.3	0.42	0.4	6.67	5.87

TABLE 13 PILOT PLANT DIVERSION DATA

RUN NUMBER	TOTAL CU YD	DIVERTED CU YD	% OF TOTAL CU YD DIVERTED	CONCENTRATE CU YD	% OF TOTAL TO CONCENTRATE
276-277	5.24	0.82	15.6	0.038	0.72
274-275	3.78	0.64	16.9	0.030	0.79
272-275	4.48	0.59	13.2	0.030	0.67
270-271	4.79	0.89	18.6	0.052	1.09
268-269	4.51	0.41	9.1	0.069	1.54
TOTAL	22.8	3.35		0.219	
AVERAGE			14.68		0.962

TABLE 14 OVERSIZE TEST RUN

RUN	1	2	TOTAL
DATE	3/4	3/6	=====
VOLUME (CU YD)	5.0	2.5	7.5
# OF DIVERSIONS	15	8	23
RUN TIME (MIN)	22	10	32
GATE OPEN TIME (SEC)	100	19	119
% OF TIME OPEN	7.6	3.2	6.2

TABLE 15 RERUN TEST ON DIVERTED MATERIALS

DATE	SORTER CLEAN (CU YD)	DECON FEED (CU YD)	DECON CLEAN (CU YD)	DECON DIVERTED (CU YD)	POND (CU YD)	CONCENTRATE (CU YD)
3/11	20.7	23.7	6.74	14.05	2.29	0.62
3/13	25.5	47.9	13.75	28.21	4.04	1.30
3/14		21.0	5.89	12.18	2.03	0.90
TOTAL	46.2	92.6	26.38	54.44	8.96	2.82

TABLE 16 PILOT PLANT RERUN OF DIVERTED MATERIAL

RUN NUMBER	TOTAL CU YD	DIVERTED CU YD	% TO DIVERT
282-283	3.9	0.57	14.7
284-285	4.13	0.52	12.6
TOTAL	8.03	1.09	
AVERAGE			13.6

TABLE 17 NARROW CONVEYOR TEST

TOTAL SOIL VOLUME (CU FT)	6.50
DIVERTED (%)	11.62
VOLUME DIVERTED (CU FT)	0.76
VOLUME CLEAN (CU FT)	5.74

TABLE 18 CONCENTRATE RERUN TEST

CONTAINER NUMBER	WEIGHT (KG)	ACTIVITY (UCI)	CONCENTRATION (NCI/GM)
1	1562	490	0.314
2	1272	560	0.440
3	1480	230	0.155
4	1398	160	0.114
5	1480	240	0.162
6	1439	200	0.139
7	1439	120	0.083
8	1439	290	0.202
TOTAL	11509	2290	
AVERAGE			0.199
CONCENTRATION AFTER RERUN			1.06

TABLE 19 DETECTOR EFFICIENCY AND COUNT RATE
(POSITION 10 - SOURCE TOP OF SOIL)

SOURCE POSITION	EFFICIENCY DETECTOR 1 (%)	COUNT RATE DETECTOR 1 (CPS)	EFFICIENCY DETECTOR 2 (%)	COUNT RATE DETECTOR 2 (CPS)	EFFICIENCY DETECTOR 3 (%)	COUNT RATE DETECTOR 3 (CPS)	TOTAL COUNT RATE (CPS)
-10	0.496%	1.11	0.496%	1.11	14.500%	32.51	34.73
-9	0.606%	1.36	0.606%	1.36	19.000%	42.62	45.34
-8	0.749%	1.68	0.749%	1.68	22.300%	49.96	53.32
-7	0.942%	2.11	0.942%	2.11	24.300%	54.36	58.58
-6	1.210%	2.70	1.210%	2.70	25.300%	56.62	62.02
-5	1.580%	3.54	1.580%	3.54	25.600%	57.30	64.38
-4	2.120%	4.75	2.120%	4.75	25.300%	56.62	66.12
-3	2.930%	6.57	2.930%	6.57	24.300%	54.36	67.50
-2	4.170%	9.35	4.170%	9.35	22.300%	49.96	68.66
-1	6.040%	13.52	6.040%	13.52	19.000%	42.62	69.67
0	8.480%	19.00	8.480%	19.00	14.500%	32.51	70.52
+1	10.900%	24.42	10.900%	24.42	9.960%	22.31	71.15
+2	12.700%	28.40	12.700%	28.40	6.560%	14.70	71.51
+3	13.800%	30.84	13.800%	30.84	4.380%	9.80	71.49
+4	14.300%	32.12	14.300%	32.12	3.010%	6.75	70.98
+5	14.500%	32.51	14.500%	32.51	2.140%	4.80	69.82
+6	14.300%	32.12	14.300%	32.12	1.570%	3.53	67.76
+7	13.800%	30.84	13.800%	30.84	1.190%	2.66	64.34
+8	12.700%	28.40	12.700%	28.40	0.919%	2.06	58.87
+9	10.900%	24.42	10.900%	24.42	0.724%	1.62	50.47
+10	8.480%	19.00	8.480%	19.00	0.581%	1.30	39.31

TABLE 20 DETECTOR EFFICIENCY AND COUNT RATE
(POSITION 10 - SOURCE 1.91 CM DEEP)

SOURCE POSITION	EFFICIENCY DETECTOR 1 (%)	COUNT RATE DETECTOR 1 (CPS)	EFFICIENCY DETECTOR 2 (%)	COUNT RATE DETECTOR 2 (CPS)	EFFICIENCY DETECTOR 3 (%)	COUNT RATE DETECTOR 3 (CPS)	TOTAL COUNT RATE (CPS)
-10	0.016%	0.037	0.016%	0.037	2.110%	4.720	4.79
-9	0.025%	0.057	0.025%	0.057	2.700%	6.040	6.15
-8	0.040%	0.089	0.040%	0.089	3.180%	7.130	7.31
-7	0.062%	0.139	0.062%	0.139	3.520%	7.880	8.16
-6	0.098%	0.220	0.098%	0.220	3.710%	8.300	8.74
-5	0.156%	0.349	0.156%	0.349	3.770%	8.440	9.13
-4	0.247%	0.552	0.247%	0.552	3.710%	8.300	9.41
-3	0.387%	0.867	0.387%	0.867	3.520%	7.880	9.61
-2	0.593%	1.330	0.593%	1.330	3.180%	7.130	9.78
-1	0.870%	1.950	0.870%	1.950	2.700%	6.040	9.94
0	1.190%	2.680	1.190%	2.680	2.110%	4.720	10.07
+1	1.520%	3.400	1.520%	3.400	1.510%	3.390	10.18
+2	1.780%	3.990	1.780%	3.990	1.010%	2.270	10.25
+3	1.970%	4.410	1.970%	4.410	0.644%	1.440	10.26
+4	2.070%	4.640	2.070%	4.640	0.399%	0.894	10.18
+5	2.110%	4.720	2.110%	4.720	0.245%	0.548	9.99
+6	2.070%	4.640	2.070%	4.640	0.150%	0.336	9.63
+7	1.970%	4.410	1.970%	4.410	0.092%	0.207	9.02
+8	1.780%	3.990	1.780%	3.990	0.057%	0.128	8.11
+9	1.520%	3.400	1.520%	3.400	0.036%	0.080	6.87
+10	1.190%	2.680	1.190%	2.680	0.023%	0.051	5.40

TABLE 21 DETECTOR EFFICIENCY AND COUNT RATE
(POSITION 7.5 - SOURCE TOP OF SOIL)

SOURCE POSITION	EFFICIENCY DETECTOR 1 (%)	COUNT RATE DETECTOR 1 (CPS)	EFFICIENCY DETECTOR 2 (%)	COUNT RATE DETECTOR 2 (CPS)	EFFICIENCY DETECTOR 3 (%)	COUNT RATE DETECTOR 3 (CPS)	TOTAL COUNT RATE (CPS)
-10	0.558%	1.25	0.413%	0.93	13.300%	29.79	31.97
-9	0.692%	1.55	0.493%	1.10	17.500%	39.14	41.79
-8	0.872%	1.95	0.594%	1.33	20.500%	45.86	49.14
-7	1.120%	2.51	0.722%	1.62	22.200%	49.84	53.97
-6	1.470%	3.30	0.887%	1.99	23.200%	51.86	57.15
-5	1.990%	4.46	1.100%	2.47	23.400%	52.48	59.41
-4	2.770%	6.21	1.390%	3.10	23.200%	51.86	61.18
-3	4.000%	8.96	1.760%	3.94	22.200%	49.84	62.74
-2	5.980%	13.40	2.240%	5.01	20.500%	45.86	64.27
-1	9.090%	20.37	2.830%	6.33	17.500%	39.14	65.84
0	13.300%	29.79	3.490%	7.81	13.300%	29.79	67.40
+1	17.500%	39.14	4.130%	9.25	9.090%	20.37	68.75
+2	20.500%	45.87	4.660%	10.45	5.980%	13.40	69.70
+3	22.200%	49.84	5.050%	11.30	4.000%	8.96	70.10
+4	23.200%	51.86	5.270%	11.80	2.770%	6.21	69.87
+5	23.400%	52.48	5.340%	11.97	1.990%	4.46	68.90
+6	23.200%	51.86	5.270%	11.80	1.470%	3.30	66.97
+7	22.200%	49.84	5.050%	11.30	1.120%	2.51	63.65
+8	20.500%	45.86	4.660%	10.45	0.872%	1.95	58.26
+9	17.500%	39.14	4.130%	9.25	0.692%	1.55	49.94
+10	13.300%	29.79	3.490%	7.81	0.558%	1.25	38.85

TABLE 22 DETECTOR EFFICIENCY AND COUNT RATE
POSITION 7.5 (SOURCE 1.91 CM DEEP)

SOURCE POSITION	EFFICIENCY DETECTOR 1 (%)	COUNT RATE DETECTOR 1 (CPS)	EFFICIENCY DETECTOR 2 (%)	COUNT RATE DETECTOR 2 (CPS)	EFFICIENCY DETECTOR 3 (%)	COUNT RATE DETECTOR 3 (CPS)	TOTAL COUNT RATE (CPS)
-10	0.021%	0.05	0.011%	0.02	1.880%	4.22	4.30
-9	0.033%	0.07	0.017%	0.04	2.410%	5.41	5.52
-8	0.052%	0.12	0.025%	0.06	2.850%	6.38	6.55
-7	0.084%	0.19	0.038%	0.08	3.150%	7.05	7.32
-6	0.135%	0.30	0.057%	0.13	3.320%	7.43	7.86
-5	0.220%	0.49	0.085%	0.19	3.370%	7.55	8.23
-4	0.357%	0.80	0.127%	0.29	3.320%	7.28	8.51
-3	0.575%	1.29	0.187%	0.42	3.150%	7.05	8.76
-2	0.903%	2.02	0.268%	0.60	2.850%	6.38	9.01
-1	1.350%	3.03	0.369%	0.83	2.410%	5.41	9.26
0	1.890%	4.22	0.481%	1.08	1.890%	4.22	9.53
+1	2.410%	5.41	0.592%	1.33	1.350%	3.03	9.76
+2	2.850%	6.38	0.686%	1.54	0.903%	2.02	9.94
+3	3.150%	7.05	0.755%	1.69	0.575%	1.29	10.03
+4	3.320%	7.43	0.797%	1.79	0.358%	0.80	10.01
+5	3.370%	7.55	0.811%	1.82	0.220%	0.49	9.86
+6	3.320%	7.43	0.797%	1.79	0.135%	0.30	9.52
+7	3.150%	7.05	0.755%	1.69	0.084%	0.19	8.93
+8	2.850%	6.38	0.686%	1.54	0.052%	0.12	8.04
+9	2.410%	5.41	0.592%	1.33	0.033%	0.07	6.81
+10	1.890%	4.22	0.481%	1.08	0.021%	0.05	5.35

TABLE 23 DETECTOR EFFICIENCY AND COUNT RATE
(POSITION 5 - SOURCE TOP OF SOIL)

SOURCE POSITION	EFFICIENCY DETECTOR 1 (%)	COUNT RATE DETECTOR 1 (CPS)	EFFICIENCY DETECTOR 2 (%)	COUNT RATE DETECTOR 2 (CPS)	EFFICIENCY DETECTOR 3 (%)	COUNT RATE DETECTOR 3 (CPS)	TOTAL COUNT RATE (CPS)
-10	0.581%	1.30	0.329%	0.74	8.480%	19.00	21.04
-9	0.724%	1.62	0.383%	0.86	10.900%	24.42	26.90
-8	0.919%	2.06	0.447%	1.00	12.700%	28.40	31.46
-7	1.190%	2.66	0.524%	1.17	13.800%	30.84	34.68
-6	1.570%	3.53	0.618%	1.38	14.300%	32.12	37.03
-5	2.140%	4.80	0.729%	1.63	14.500%	32.51	38.95
-4	3.010%	6.75	0.862%	1.93	14.300%	32.12	40.79
-3	4.380%	9.80	1.020%	2.28	13.800%	30.84	42.92
-2	6.560%	14.70	1.190%	2.67	12.700%	28.40	45.78
-1	9.960%	22.31	1.380%	3.10	10.900%	24.42	49.83
0	14.500%	32.51	1.580%	3.54	8.480%	19.00	55.05
+1	19.000%	42.62	1.760%	3.95	6.040%	13.52	60.10
+2	22.300%	49.96	1.920%	4.31	4.170%	9.35	63.62
+3	24.270%	54.36	2.040%	4.58	2.930%	6.57	65.51
+4	25.270%	56.62	2.120%	4.75	2.120%	4.75	66.11
+5	25.580%	57.30	2.140%	4.80	1.580%	3.54	65.65
+6	25.270%	56.62	2.120%	4.75	1.210%	2.70	64.07
+7	24.270%	54.36	2.040%	4.58	0.942%	2.11	61.05
+8	22.300%	49.96	1.920%	4.31	0.750%	1.68	55.95
+9	19.030%	42.62	1.760%	3.95	0.606%	1.36	47.93
+10	14.500%	32.51	1.580%	3.54	0.496%	1.11	37.16

TABLE 24 DETECTOR EFFICIENCY AND COUNT RATE
(POSITION 5 - SOURCE 1.91 CM DEEP)

SOURCE POSITION	EFFICIENCY DETECTOR 1 (%)	COUNT RATE DETECTOR 1 (CPS)	EFFICIENCY DETECTOR 2 (%)	COUNT RATE DETECTOR 2 (CPS)	EFFICIENCY DETECTOR 3 (%)	COUNT RATE DETECTOR 3 (CPS)	TOTAL COUNT RATE (CPS)
-10	0.023%	0.05	0.006%	0.01	1.190%	2.67	2.74
-9	0.036%	0.08	0.009%	0.02	1.520%	3.40	3.50
-8	0.057%	0.13	0.013%	0.03	1.780%	3.99	4.15
-7	0.092%	0.21	0.019%	0.04	1.970%	4.41	4.66
-6	0.150%	0.34	0.028%	0.06	2.070%	4.64	5.04
-5	0.245%	0.55	0.039%	0.09	2.110%	4.72	5.36
-4	0.399%	0.89	0.054%	0.12	2.070%	4.64	5.66
-3	0.644%	1.44	0.074%	0.17	1.970%	4.41	6.02
-2	1.010%	2.27	0.098%	0.22	1.780%	3.99	6.48
-1	1.510%	3.39	0.126%	0.28	1.520%	3.40	7.07
0	2.110%	4.72	0.156%	0.35	1.190%	2.68	7.75
+1	2.700%	6.04	0.184%	0.41	0.870%	1.95	8.40
+2	3.180%	7.13	0.209%	0.47	0.593%	1.33	8.93
+3	3.510%	7.88	0.229%	0.51	0.387%	0.87	9.26
+4	3.710%	8.30	0.241%	0.54	0.247%	0.55	9.39
+5	3.770%	8.44	0.245%	0.55	0.156%	0.35	9.33
+6	3.700%	8.30	0.241%	0.54	0.098%	0.22	9.06
+7	3.520%	7.88	0.229%	0.51	0.062%	0.14	8.53
+8	3.180%	7.13	0.209%	0.47	0.040%	0.09	7.68
+9	2.700%	6.04	0.184%	0.41	0.025%	0.06	6.51
+10	2.110%	4.72	0.156%	0.35	0.016%	0.04	5.11

TABLE 25 DETECTOR EFFICIENCY AND COUNT RATE
(POSITION 3.81 - SOURCE TOP OF SOIL)

SOURCE POSITION	EFFICIENCY DETECTOR 1 (%)	COUNT RATE DETECTOR 1 (CPS)	EFFICIENCY DETECTOR 2 (%)	COUNT RATE DETECTOR 2 (CPS)	EFFICIENCY DETECTOR 3 (%)	COUNT RATE DETECTOR 3 (CPS)	TOTAL COUNT RATE (CPS)
-10	0.576%	1.29	0.293%	0.66	5.630%	12.61	14.56
-9	0.717%	1.61	0.336%	0.75	6.970%	15.60	17.96
-8	0.908%	2.03	0.387%	0.87	8.010%	17.95	20.85
-7	1.170%	2.63	0.447%	1.00	8.710%	19.50	23.13
-6	1.550%	3.47	0.517%	1.16	9.090%	20.36	24.99
-5	2.110%	4.72	0.599%	1.34	9.210%	20.63	26.69
-4	2.960%	6.62	0.692%	1.55	9.090%	20.36	28.53
-3	4.290%	9.62	0.796%	1.78	8.710%	19.50	30.90
-2	6.440%	14.42	0.911%	2.04	8.010%	17.95	34.41
-1	9.780%	21.90	1.030%	2.31	6.970%	15.60	39.81
0	14.300%	31.95	1.150%	2.58	5.630%	12.61	47.13
+1	18.700%	41.91	1.260%	2.82	4.270%	9.57	54.30
+2	21.900%	49.13	1.360%	3.04	3.150%	7.06	59.23
+3	23.900%	53.44	1.430%	3.20	2.330%	5.23	61.87
+4	24.800%	55.65	1.470%	3.30	1.760%	3.93	62.88
+5	25.100%	56.32	1.490%	3.34	1.350%	3.02	62.68
+6	24.800%	55.65	1.470%	3.30	1.050%	2.36	61.31
+7	23.900%	53.44	1.430%	3.20	0.838%	1.88	58.52
+8	21.900%	49.13	1.360%	3.04	0.677%	1.52	53.68
+9	18.700%	41.91	1.260%	2.82	0.553%	1.24	45.98
+10	14.300%	31.95	1.150%	2.58	0.458%	1.03	35.55

TABLE 26 DETECTOR EFFICIENCY AND COUNT RATE
(POSITION 3.81 - SOURCE 1.91 CM DEEP)

SOURCE POSITION	EFFICIENCY DETECTOR 1 (%)	COUNT RATE DETECTOR 1 (CPS)	EFFICIENCY DETECTOR 2 (%)	COUNT RATE DETECTOR 2 (CPS)	EFFICIENCY DETECTOR 3 (%)	COUNT RATE DETECTOR 3 (CPS)	TOTAL COUNT RATE (CPS)
-10	0.022%	0.05	0.005%	0.01	0.812%	1.82	1.88
-9	0.035%	0.08	0.007%	0.02	1.020%	2.28	2.37
-8	0.056%	0.13	0.010%	0.02	1.190%	2.67	2.81
-7	0.090%	0.20	0.014%	0.03	1.310%	2.94	3.18
-6	0.147%	0.33	0.019%	0.04	1.390%	3.10	3.47
-5	0.239%	0.54	0.026%	0.06	1.410%	3.15	3.75
-4	0.390%	0.87	0.035%	0.08	1.380%	3.10	4.05
-3	0.628%	1.41	0.046%	0.10	1.310%	2.94	4.45
-2	0.987%	2.21	0.059%	0.13	1.190%	2.67	5.01
-1	1.480%	3.31	0.074%	0.17	1.020%	2.28	5.76
0	2.060%	4.61	0.090%	0.20	0.812%	1.82	6.63
+1	2.640%	5.90	0.105%	0.24	0.604%	1.35	7.49
+2	3.110%	6.97	0.118%	0.27	0.423%	0.95	8.18
+3	3.440%	7.70	0.128%	0.29	0.284%	0.64	8.62
+4	3.620%	8.11	0.135%	0.30	0.186%	0.42	8.83
+5	3.680%	8.24	0.137%	0.31	0.120%	0.27	8.82
+6	3.620%	8.11	0.135%	0.30	0.078%	0.17	8.59
+7	3.440%	7.70	0.128%	0.29	0.050%	0.11	8.10
+8	3.110%	6.97	0.118%	0.27	0.032%	0.07	7.30
+9	2.640%	5.90	0.105%	0.24	0.021%	0.05	6.19
+10	2.060%	4.61	0.090%	0.20	0.014%	0.03	4.85

TABLE 27 CALIBRATION AT 1.91 CM SOIL DEPTH

54.1 NCI AM-241 SOURCE AT GRID LOCATION X=10 CM, Y=+2 CM
 87.5 NCI AM-241 SOURCE AT GRID LOCATION X=7.5 CM, Y=+7 CM

DETECTOR	GROSS COUNTS IN ROI (2 MIN)	GROSS COUNTS IN ROI (CPS)	BACKGROUND COUNTS IN ROI (CPS)	NET COUNTS IN ROI (CPS)	UPPER & LOWER SCA COUNT (CPS)
1	189.00	1.58	1.85	-0.28	0.00
2	260.00	2.17	2.12	0.05	0.00
3	312.00	2.60	2.34	0.26	0.00
4	291.00	2.43	2.22	0.20	0.00
5	231.00	1.93	1.94	-0.01	0.00
6	373.00	3.11	3.03	0.08	0.00
7	1973.00	16.44	2.22	14.22	13.00
8	3234.00	26.95	2.18	24.77	22.00
9	243.00	2.03	2.37	-0.35	0.00
10	2106.00	17.55	2.48	15.07	13.00
11	8065.00	67.21	2.28	64.93	59.00
12	366.00	3.05	2.65	0.40	1.00
13	256.00	2.13	2.37	-0.24	0.00
14	320.00	2.67	2.21	0.46	0.00
15	1474.00	12.28	2.13	10.15	9.00
TOTAL	19693.00	164.11	34.39	129.72	117.00

EFFICIENCY CALCULATIONS

DETECTOR POSITIONS	CALCULATED EFFICIENCY (%)	MEASURED EFFICIENCY BKG SUBTRACT METHOD (%)	MEASURED EFFICIENCY UPPER/LOWER SCA METHOD (%)
7,8&15	4.57	6.69	5.95
3,10&11	3.99	6.64	6.00

TABLE 28 DIVERSION GATE TIMING TESTS

TEST NUMBER	ACTIVITY Am -241 (NCI)	DIVERT SIGNAL (SEC)	DURATION OF DIVERSION (SEC)	TIME TO EJECT (SEC)	LOCATION ON BELT	COMMENTS
1	10,317.0	31	10.00	Normal	B Center	
2	" "	31	14.48	4.00	B Side	
3	" "	31	13.96	6.30	" "	
4	" "	31	9.74	4.64	" "	
5	" "	31	11.84	4.47	" "	
6	" "	31	21.99	8.35	B Center	Initial start slow
7	" "	31	11.98	3.81	" "	
8	" "	31	10.14	3.60	" "	
9	60.6	31	7.09	0.25	B Side	Too Quick
10	" "	31	5.90	0.67	" "	" "
11	" "	31	5.99	0.54	" "	" "
12	" "	31	6.74	1.20	" "	ok
13	" "	31	6.17	0.59	" "	Too Quick
14	" "	31	5.37	DNE	" "	Did not eject
15	41.9	31	5.84	1.24	" "	
16	" "	31	5.97	2.52	" "	
17	" "	31	6.30	0.90	" "	
18	" "	31	14.14	1.40	B center	
19	60.6	30	5.97	1.59	B side	
20	" "	30	5.54	1.89	" "	
21	" "	30	6.00	2.20	" "	
22	" "	30	5.36	1.45	" "	
23	" "	30	6.17	3.14	" "	
24	" "	30	6.26	2.86	" "	
25	" "	30	6.05	1.54	" "	
26	" "	30	6.14	2.20	" "	
27	" "	30	6.06	2.34	" "	
28	" "	30	6.56	2.14	" "	
29	" "	30	12.71	1.20	B center	
30	" "	30	8.14	1.84	" "	
31	" "	30	10.17	2.87	" "	
32	" "	30	6.07	2.24	" "	
33	" "	30	5.43	1.29	" "	
34	41.9	30	4.08	1.07	B side	
35	" "	30	4.06	1.83	" "	
36	" "	30	6.20	1.95	" "	
37	" "	30	4.21	1.14	" "	
38	" "	30	6.27	2.96	" "	
39	" "	30	6.12	2.09	B center	
40	" "	30	5.67	2.41	" "	
41	" "	30	6.22	2.40	" "	
42	" "	30	5.87	3.20	" "	
43	" "	30	6.02	2.12	" "	
44	26.9	30	4.57	DNE	B side	Did not eject
45	" "	30	4.47	2.00	" "	
46	" "	30	4.24	1.58	" "	
47	" "	30	4.13	1.67	" "	
48	" "	30	4.02	1.39	" "	
49	" "	30	4.18	1.09	" "	
50	" "	30	6.22	2.26	B center	
51	" "	30	6.47	1.52	" "	
52	" "	30	6.16	2.40	" "	
53	" "	30	5.75	1.65	" "	
54	" "	30	6.09	2.43	" "	
55	" "	30	DNE	DNE	" "	Did not eject
56	" "	30	4.49	1.08	" "	
57	" "	30	6.23	2.22	" "	
58	" "	30	4.16	0.90	" "	Too quick
59	" "	30	DNE	DNE	A center	Did not eject
60	" "	30	4.49	1.08	" "	
61	" "	30	6.23	2.22	" "	
62	" "	30	4.16	0.90	" "	Too quick
63	886.6	30	6.03	2.71	A edge	
64	157.9	30	11.90	2.84	" "	
65	82.5	30	10.13	2.74	" "	

TABLE 28 DIVERSION GATE TIMING TESTS

TEST NUMBER	ACTIVITY Am -241 (NCI)	DIVERT SIGNAL (SEC)	DURATION OF DIVERSION (SEC)	TIME TO EJECT (SEC)	LOCATION ON BELT	COMMENTS
66	41.9	30	5.30	1.57	"	
67	18.0	30	DND	DND	"	Did not divert
68	886.6	30	12.14	3.19	A center	
69	157.9	30	11.90	2.84	"	
70	82.5	30	10.30	0.93	"	Too quick
71	41.9	30	4.26	0.77	"	Too quick
72	18.0	30	4.14	0.90	"	Too quick
73	886.6	29	5.99	3.27	A edge	
74	157.9	29	9.30	3.40	"	
75	82.5	29	10.61	3.30	"	
76	41.9	29	6.01	2.79	"	
77	18.0	29	4.45	0.94	"	Too quick
78	886.6	29	6.64	3.24	A center	
79	157.9	29	10.00	2.27	"	
80	82.5	29	12.09	3.04	"	
81	41.9	29	5.60	2.56	"	
82	18.0	29	6.54	2.78	"	
83	886.6	28	22.05	12.82	A edge	
84	157.9	28	11.87	5.07	"	
85	82.5	28	12.17	11.09	"	close
86	41.9	28	5.46	3.44	"	
87	18.0	28	DND	DND	"	Did not divert
88	886.6	28	8.06	4.80	A center	
89	157.9	28	22.57	12.09	"	Maybe 886.6 uCi
90	82.5	28	12.50	4.51	"	
91	41.9	28	5.55	2.65	"	
92	18.0	28	DND	DND	"	Did not divert
93	886.6	27	7.31	6.38	A edge	Too close
94	157.9	27	7.94	5.14	"	
95	82.5	27	9.98	4.50	"	
96	41.9	27	7.16	5.50	"	
97	18.0	27	5.08	3.98	"	
98	886.6	27	12.01	6.18	A center	
99	157.9	27	6.51	4.12	"	
100	82.5	27	6.17	4.15	"	
101	41.9	27	6.40	5.27	"	
102	18.0	27	DND	DND	"	Did not divert
103	886.6	31	22.49	9.87	A edge	
104	157.9	31	6.34	DNE	"	Did not eject
105	82.5	31	12.47	12.07	"	Questionable
106	41.9	31	6.06	0.84	"	Too quick
107	18.0	31	DND	DND	"	did not divert
108	886.6	31	22.06	9.50	A center	
109	157.9	31	7.94	0.57	"	Too quick
110	82.5	31	6.07	0.01	"	Too quick
111	41.9	31	6.48	1.04	"	
112	18.0	31	2.59	0.52	"	Too quick

TABLL - SAMPLE TRAY COUNTS

DATE & CODE # ORIGIN	COUNT TIME & MODE MIN	DETECTOR COUNT RATE (CPS)															CPS TOTAL ARRAY	TRAY ACTIVITY (BQ/KG)
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
FEB 16	B 10	2.45	3.47	2.79	2.80	2.61	3.91	3.96	2.49	4.47	5.44	4.10	5.19	3.97	13.80	3.41	64.85	436
CR 14	C 10	1	1	1	0	1	1	2	0	3	3	2	2	2	11	1	31	
DECON	B-H	0.85	1.60	0.77	0.91	0.68	1.18	2.05	0.59	2.42	3.35	1.84	2.83	2.13	11.80	1.57	34.57	
	H	1.60	1.87	2.02	1.88	1.93	2.73	1.92	1.90	2.05	2.09	2.26	2.36	1.85	1.99	1.84	30.28	
FEB 17	B 10	2.22	7.95	8.36	6.16	4.59	4.38	3.46	7.29	18.71	20.74	4.02	3.60	2.84	2.83	3.47	100.60	858
CR 15	C 10	0	5	6	3	2	2	1	5	15	16	2	1	1	1	1	61	
DECON	B-H	0.61	6.08	6.34	4.28	2.66	1.65	1.54	5.38	16.66	18.66	1.76	1.25	0.99	0.84	1.63	70.32	
FEB 18	B 10	1.75	2.85	3.56	5.17	5.04	10.85	6.50	3.11	2.84	3.17	3.82	3.62	2.96	3.63	10.81	69.66	450
CR 17	C 10	0	1	1	2	3	6	4	1	1	1	1	1	1	1	8	32	
DECON	B-H	0.15	0.98	1.54	3.28	3.10	8.12	4.58	1.21	0.78	1.09	1.56	1.26	1.11	1.64	8.97	39.38	
FEB 20	B 10	1.70	2.98	4.75	3.14	3.04	4.07	6.76	11.83	7.06	3.22	3.24	3.60	12.85	4.37	4.02	76.60	562
CR 20	C 10	0	1	2	1	1	1	4	9	4	1	1	1	10	2	2	40	
DECON	B-H	0.10	1.11	2.73	1.25	1.11	1.34	4.84	9.92	5.00	1.14	0.97	1.25	11.00	2.38	2.18	46.32	
FEB 21	B 10	1.61	2.51	2.99	3.48	2.73	3.53	3.81	2.72	2.26	2.83	2.68	3.37	2.95	8.38	4.44	50.28	281
CR 22	C 10	0	1	1	1	1	1	2	1	0	1	1	1	1	6	2	20	
DECON	B-H	0.01	0.64	0.97	1.60	0.79	0.80	1.90	0.82	0.21	0.75	0.42	1.01	1.10	6.38	2.60	20.00	
FEB 22	B 10	1.60	7.76	13.33	2.37	2.42	3.29	4.59	2.11	2.20	2.60	3.09	2.78	2.79	2.41	3.05	56.37	309
CR 26	C 10	0	5	10	0	0	1	3	0	0	1	1	0	0	0	1	22	
DECON	B-H	0.00	5.89	11.31	0.49	0.48	0.56	2.67	0.21	0.15	0.51	0.83	0.42	0.94	0.41	1.21	26.09	
FEB 23	B 10	1.58	2.39	2.58	2.81	2.40	3.09	2.64	2.61	2.21	3.12	3.32	2.91	2.46	3.02	4.00	41.12	169
CR 27	C 10	0	1	1	0	1	1	1	1	0	1	1	1	0	1	2	12	
DECON	B-H	-0.02	0.52	0.56	0.93	0.46	0.36	0.72	0.71	0.16	1.03	1.05	0.55	0.61	1.02	2.16	10.84	
FEB 24	B 10	1.89	2.44	2.99	2.73	2.63	3.05	3.33	2.78	4.90	2.78	3.39	5.41	2.62	2.37	2.37	45.67	183
CR 31	C 10	0	1	1	0	1	1	1	1	2	0	1	2	1	1	0	13	
DECON	B-H	0.29	0.57	0.97	0.85	0.69	0.32	1.41	0.88	2.85	0.69	1.13	3.05	0.77	0.37	0.53	15.39	
FEB 24	B 10	2.11	12.24	3.84	4.59	2.60	3.45	2.91	3.46	2.35	2.87	14.53	8.07	2.49	2.33	2.40	70.23	464
CR 32	C 10	0	9	1	2	1	1	1	1	1	1	11	3	0	0	1	33	
decon	B-H	0.51	10.37	1.82	2.71	0.67	0.72	0.99	1.56	0.30	0.78	12.26	5.71	0.64	0.33	0.56	39.95	
FEB 25	B 2	3.45	5.49	5.99	3.42	9.63	9.08	3.20	2.33	3.43	3.34	3.58	3.31	2.98	2.71	2.52	64.45	323
CR 36	C 4	1	3	3	1	7	0	1	0	1	1	1	1	1	1	1	23	
DECON	B-H	1.85	3.62	3.97	1.54	7.69	6.36	1.28	0.42	1.37	1.26	1.32	0.95	1.14	0.71	0.68	34.17	
FEB 25	B 2	1.91	3.14	5.31	8.76	3.94	3.73	3.00	2.71	3.48	3.30	3.24	3.36	2.99	3.27	3.02	55.15	309
CR 35	C 4	0	1	3	6	2	1	1	1	1	1	1	1	1	1	1	22	
SORTER	B-H	0.31	1.27	3.29	6.88	2.01	1.00	1.08	0.81	1.43	1.21	0.98	1.00	1.14	1.28	1.18	24.87	

TABLE - SAMPLE TRAY COUNTS

DATE & CODE # ORIGIN	COUNT TIME & MODE MIN	DETECTOR COUNT RATE (CPS)															CPS TOTAL ARRAY	TRAY ACTIVITY (BQ/KG)
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
FEB 27	B 2	1.92	3.32	3.50	3.73	2.29	2.80	2.48	2.13	2.57	3.45	3.60	3.31	2.32	2.29	2.34	42.03	127
CR 41	C 4	0	1	1	1	1	1	0	0	1	1	1	1	0	0	0	9	
DECON	B-H	0.32	1.45	1.48	1.84	0.36	0.07	0.56	0.23	0.52	1.36	1.34	0.95	0.47	0.30	0.51	11.75	
FEB 27	B 2	1.58	3.95	3.83	4.41	4.42	4.96	4.83	3.56	3.51	4.58	5.08	5.40	4.33	4.38	3.95	62.73	394
CR 41	C 4	0	2	2	2	2	2	3	1	1	2	3	2	2	2	2	28	
SORTER	B-H	-0.03	2.08	1.81	2.53	2.49	2.23	2.91	1.66	1.46	2.49	2.81	3.04	2.48	2.38	2.11	32.45	
FEB 28	B 2	2.42	3.84	4.23	18.86	4.26	5.11	4.19	3.43	2.91	3.67	4.06	4.08	3.43	3.90	3.56	71.93	478
CR 45	C 4	0	2	2	14	2	2	2	1	1	1	2	1	1	2	1	34	
SORTER	B-H	0.82	1.97	2.21	16.98	2.33	2.38	2.28	1.53	0.86	1.58	1.80	1.73	1.58	1.91	1.72	41.65	
MAR 1	B 4	1.63	2.91	5.10	5.27	6.82	4.14	3.93	2.94	2.14	2.72	4.59	4.61	5.42	2.65	2.41	57.28	337
CR 47	C 4	0	1	2	3	5	1	2	1	0	1	2	2	3	0	1	24	
DECON	B-H	0.03	1.04	3.08	3.39	4.89	1.41	2.02	1.04	0.09	0.63	2.33	2.25	3.57	0.66	0.58	27.00	
MAR 1	B 2	2.05	3.59	7.15	4.48	2.95	3.64	3.22	3.01	3.04	3.38	4.22	3.50	3.55	4.17	2.98	54.92	309
CR 48	C 4	0	2	5	2	1	1	1	1	1	1	2	1	1	2	1	22	
SORTER	B-H	0.45	1.72	5.13	2.60	1.02	0.92	1.30	1.11	0.99	1.29	1.96	1.14	1.70	2.17	1.14	24.64	
MAR 2	B 2	1.74	2.31	5.62	34.81	3.49	4.03	2.42	2.56	8.03	3.33	4.67	3.30	2.68	2.46	2.53	83.97	633
CR 51	C 4	0	0	3	30	1	1	1	1	5	1	2	0	0	0	0	45	
DECON	B-H	0.14	0.44	3.60	32.93	1.56	1.31	0.50	0.66	5.98	1.25	2.41	0.94	0.83	0.46	0.69	53.69	
MAR 2	B 2	4.11	7.56	5.17	2.99	2.68	3.56	3.72	7.01	2.83	3.63	4.34	3.50	3.68	5.88	2.58	63.23	394
CR 51	C 4	2	5	2	0	1	1	1	5	1	1	2	1	1	4	1	28	
SORTER	B-H	2.51	5.69	3.15	1.11	0.75	0.83	1.80	5.11	0.77	1.55	2.08	1.14	1.83	3.89	0.74	32.95	
MAR 3	B 2	1.61	2.44	2.46	2.85	3.34	3.22	3.79	2.63	2.50	2.86	2.81	3.25	3.57	3.27	3.18	43.77	155
CR 56	C 4	0	0	1	0	1	1	2	1	0	0	1	1	1	1	1	11	
DECON	B-H	0.01	0.57	0.44	0.97	1.41	0.49	1.88	0.72	0.45	0.77	0.55	0.89	1.72	1.27	1.35	13.49	
MAR 3	B 2	2.25	10.58	5.45	3.57	3.91	11.55	15.23	2.92	3.41	3.86	3.78	3.37	3.46	3.43	3.21	79.95	534
CR 56	C 4	0	8	3	1	1	6	11	0	1	1	1	1	1	2	1	38	
SORTER	B-H	0.65	8.70	3.43	1.69	1.98	8.82	13.31	1.01	1.36	1.77	1.51	1.01	1.61	1.44	1.37	49.67	
MAR 4	B 2	1.66	2.99	2.54	2.40	4.57	3.33	2.55	2.43	4.24	2.87	2.73	2.73	2.53	2.71	2.48	42.74	155
CR 57	C 4	0	1	1	0	1	1	1	0	2	1	1	1	0	0	1	11	
DECON	B-H	0.06	1.12	0.52	0.52	2.64	0.60	0.63	0.53	2.19	0.78	0.46	0.37	0.69	0.71	0.64	12.46	
MAR 6	B 2	3.41	28.49	4.08	3.47	2.75	3.24	2.73	3.09	2.68	3.12	4.16	2.92	3.18	3.53	2.34	73.18	548
CR 59	C 4	2	23	2	1	1	1	1	1	1	1	2	1	1	1	0	39	
DECON	B-H	1.81	26.62	2.06	1.59	0.82	0.52	0.82	1.19	0.62	1.03	1.90	0.56	1.34	1.53	0.51	42.90	
MAR 6	B 2	2.11	3.88	6.08	3.52	3.18	3.46	3.79	2.88	3.92	4.11	11.44	4.45	3.15	3.23	3.05	62.24	

TAB. 1 - SAMPLE TRAY COUNTS

DATE & CODE # ORIGIN	COUNT TIME & MODE MIN	DETECTOR COUNT RATE (CPS)															CPS TOTAL ARRAY	TRAY ACTIVITY (BQ/KG)
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
CR 59	C 4	0	1	4	1	1	1	2	0	1	2	9	1	1	1	1	26	366
SORTER	B-H	0.51	2.00	4.06	1.64	1.24	0.73	1.88	0.98	1.87	2.02	9.18	2.09	1.30	1.24	1.21	31.96	
MAR 7	B 2	2.17	3.30	3.68	12.63	2.64	2.64	2.34	2.33	2.63	3.77	10.33	5.03	2.68	3.29	2.23	61.69	337
CR 63	C 4	0	1	1	9	0	1	1	0	0	1	7	1	1	1	0	24	
DECON	B-H	0.57	1.43	1.66	10.74	0.71	-0.08	0.43	0.43	0.58	1.68	8.07	2.67	0.83	1.30	0.40	31.41	
MAR 7	B 2	3.21	2.77	3.78	3.08	2.98	5.75	3.26	3.64	2.33	2.77	5.33	3.68	3.40	11.43	18.07	75.43	548
CR 63	C 4	1	1	2	1	1	2	1	1	0	1	2	1	1	9	15	39	
SORTER	B-H	1.61	0.90	1.76	1.19	1.04	3.02	1.34	1.74	0.27	0.68	3.06	1.32	1.55	9.43	16.23	45.15	
MAR 8	B 2	1.79	2.47	3.78	4.47	3.76	5.63	3.43	3.36	2.46	4.53	3.49	2.76	2.88	3.19	4.29	52.29	253
CR 67	C 4	0	0	1	1	2	1	2	1	1	3	1	1	1	1	2	18	
DECON	B-H	0.19	0.60	1.76	2.59	1.83	2.90	1.52	1.46	0.41	2.45	1.23	0.40	1.04	1.20	2.46	22.01	
MAR 8	B 2	1.68	3.08	3.37	3.15	4.42	7.25	4.05	3.29	2.93	3.56	3.56	3.58	3.89	4.48	7.90	60.19	281
CR 67	C 4	0	1	1	1	2	2	1	1	1	1	1	1	1	2	4	20	
SORTER	B-H	0.08	1.20	1.35	1.27	2.49	4.52	2.13	1.39	0.88	1.47	1.30	1.23	2.04	2.49	6.06	29.91	
MAR 9	B 2	1.78	2.66	3.83	2.78	2.49	3.22	2.17	2.52	2.59	3.80	3.45	3.04	2.43	2.28	2.25	41.28	112
CR 69	C 4	0	1	2	0	0	1	0	0	0	2	1	1	0	0	0	8	
DECON	B-H	0.17	0.79	1.81	0.89	0.56	0.49	0.25	0.61	0.54	1.71	1.19	0.69	0.58	0.29	0.41	11.00	
MAR 9	B 2	2.46	37.90	6.59	3.48	3.16	3.38	3.14	4.81	3.21	4.20	3.79	7.40	4.36	2.72	2.77	93.37	759
CR 69	C 4	0	32	4	1	1	1	1	3	1	2	1	3	2	1	1	54	
SORTER	B-H	0.86	36.03	4.57	1.60	1.23	0.66	1.23	2.91	1.16	2.11	1.53	5.04	2.51	0.72	0.93	63.09	
MAR 10	B 2	1.75	2.29	2.36	2.55	2.75	7.06	11.77	8.47	2.36	3.10	2.98	2.64	4.58	10.32	2.86	67.83	394
CR 72	C 4	0	0	0	0	1	1	8	6	0	1	1	1	2	7	0	28	
DECON	B-H	0.15	0.42	0.34	0.67	0.82	4.33	9.85	6.56	0.31	1.01	0.71	0.29	2.74	8.32	1.02	37.55	
MAR 10	B 2	2.19	3.89	4.10	4.33	6.62	4.83	4.63	2.92	4.13	4.66	4.64	5.79	4.37	3.86	3.58	64.53	352
CR 72	C 4	0	2	1	1	4	1	2	1	2	2	2	2	2	2	1	25	
SORTER	B-H	0.59	2.02	2.08	2.45	4.69	2.10	2.72	1.01	2.08	2.57	2.38	3.44	2.52	1.86	1.74	34.25	
MAR 11	B 2	3.26	5.94	2.68	2.92	2.51	3.06	2.20	2.41	2.31	2.96	3.84	4.50	2.50	2.57	3.20	46.85	197
CR 75	C 4	2	3	1	0	1	1	0	0	1	1	1	2	0	0	1	14	
DECON	B-H	1.66	4.07	0.66	1.04	0.58	0.33	0.28	0.51	0.26	0.87	1.58	2.14	0.65	0.57	1.36	16.57	
MAR 11	B 2	1.91	4.38	3.75	3.44	3.09	3.29	2.66	3.57	3.30	3.38	4.70	3.79	2.98	3.15	3.34	50.73	225
CR 75	C 4	0	2	1	1	1	1	1	1	1	1	2	0	1	1	2	16	
SORTER	B-H	0.31	2.51	1.73	1.56	1.16	0.57	0.74	1.66	1.25	1.29	2.44	1.44	1.14	1.16	1.51	20.45	
MAR 13	B 2	2.38	3.41	2.65	2.66	2.71	2.96	2.58	4.68	2.44	3.38	2.88	2.87	2.21	2.43	19.99	60.23	

Tab. 9 - SAMPLE TRAY COUNTS

DATE & CODE # ORIGIN	COUNT TIME & MODE MIN	DETECTOR COUNT RATE (CPS)															CPS TOTAL ARRAY	TRAY ACTIVITY (BQ/KG)
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
CR 78	C 4	1	2	0	0	1	0	1	3	1	1	1	1	0	1	17	30	422
DECON	B-H	0.77	1.54	0.63	0.78	0.78	0.23	0.67	2.78	0.39	1.30	0.62	0.51	0.36	0.43	18.16	29.95	
MAR 13	B 2	1.94	2.97	4.96	3.30	3.72	4.95	2.96	2.63	2.87	4.91	7.42	8.07	3.68	3.37	2.74	60.47	
CR 78	C 4	0	1	3	0	2	1	1	0	1	2	5	4	1	1	1	23	323
SORTER	B-H	0.34	1.10	2.94	1.42	1.79	2.22	1.04	0.72	0.82	2.82	5.16	5.71	1.84	1.37	0.91	30.19	
MAR 14	B 2	2.85	6.37	3.68	3.37	2.23	2.91	4.85	2.28	2.02	2.43	3.38	3.11	2.00	2.76	2.16	46.36	
CR 83	C 4	1	4	2	1	0	1	3	1	0	0	1	0	0	1	1	16	225
DECON	B-H	1.25	4.50	1.66	1.49	0.29	0.18	2.93	0.37	-0.03	0.34	1.11	0.75	0.15	0.76	0.32	16.08	
MAR 14	B 2	1.43	1.80	2.26	1.94	1.78	2.67	2.53	3.45	2.32	2.11	2.12	2.23	1.77	1.85	2.40	32.65	
CR 84	C 4	0	1	1	1	1	1	2	4	1	1	1	1	1	1	1	18	253
SORTER	B-H	-0.18	-0.07	0.24	0.06	-0.15	-0.06	0.62	1.55	0.27	0.02	-0.14	-0.12	-0.08	-0.14	0.56	2.37	
MAR 15	B 2	1.58	2.35	2.94	5.90	2.65	3.32	2.42	2.11	2.53	2.49	3.26	4.64	4.21	2.43	2.43	45.24	
CR 84	C 4	0	0	1	3	1	1	0	1	0	1	1	1	2	0	1	13	183
DECON	B-H	-0.03	0.48	0.92	4.02	0.72	0.59	0.50	0.21	0.47	0.41	1.00	2.29	2.36	0.44	0.59	14.96	
MAR 15	B 2	1.68	3.55	4.58	6.94	8.36	5.83	4.81	4.15	3.19	5.29	4.52	49.15	54.04	4.53	4.58	165.19	
CR 84	C 4	0	2	2	3	6	1	3	2	1	3	2	18	47	2	2	94	1322
SORTER	B-H	0.07	1.68	2.56	5.06	6.43	3.11	2.89	2.25	1.14	3.21	2.26	46.79	52.19	2.53	2.74	134.91	
MAR 16	B 2	2.16	7.70	4.65	3.11	3.33	10.68	5.20	2.35	4.91	5.47	3.54	2.86	3.18	2.83	2.48	64.43	
CR 87	C 4	0	5	3	1	1	6	3	0	2	3	1	1	1	1	0	28	394
DECON	B-H	0.56	5.83	2.63	1.23	1.39	7.95	3.28	0.45	2.86	3.38	1.28	0.50	1.34	0.84	0.64	34.15	
MAR 16	B 2	2.04	5.08	4.48	3.27	3.73	3.69	4.90	5.98	3.95	5.31	4.98	4.49	3.78	4.97	6.78	67.43	
CR 87	C 4	0	3	-	1	1	1	3	4	1	2	2	2	2	3	5	32	450
SORTER	B-H	0.44	3.21	2.46	1.39	1.80	0.97	2.98	4.08	1.90	3.22	2.71	2.14	1.94	2.97	4.95	37.15	
MAR 17	B 2	1.73	1.89	2.02	2.48	4.47	3.15	3.36	2.76	2.39	2.06	2.40	3.19	2.30	4.18	12.96	51.32	
CR 89	C 4	0	0	0	0	2	0	2	0	0	0	0	0	0	2	10	16	225
DECON	B-H	0.12	0.02	0.00	0.59	2.54	0.42	1.44	0.86	0.34	-0.03	0.14	0.84	0.45	2.18	11.12	21.04	
																	=====	
																	AVERAGE	382

SYMBOL CODE

B2 = DETECTOR MODE B FOR TWO MINUTES - NO BACKGROUND SUBTRACT

C 4 = DETECTOR MODE C FOR FOUR MINUTES - BACKGROUND SUBTRACT OPTION ONE

B - H = CLEAN SOIL STANDARD BACKGROUND SUBTRACT - H DETERMINED FROM CLEAN SOIL COUNT

TABLE 30 - PARTICLES FROM ASSAY TRAYS

DATE 1989	SAMPLE CODE	SAMPLE STREAM	ACTIVITY (BQ)	3 DETECTOR COUNT (CPS)	GAMMA EFFICIENCY (%)
FEB 17	CR 15	DECON	1761	36	36.7
FEB 18	CR 17	DECON	1994	13	11.7
FEB 20	CR 20	DECON	4143	21	9.1
			1415	14	17.8
FEB 21	CR 22	DECON	1701	5	5.3
			1794	5	5.0
FEB 22	CR 26	DECON	3077	18	10.5
FEB 24	CR 32	DECON	932	9	17.3
			3522	16	8.2
FEB 28	CR 45	SORTER	2839	18	11.4
MAR 2	CR 51	DECON	1810	33	32.7
			570	6	18.9
MAR 3	CR 56	SORTER	1865	19	18.3
MAR 7	CR 63	SORTER	2745	25	16.3
MAR 9	CR 69	SORTER	3056	38	22.3
MAR 10	CR 72	DECON	3263	16	8.8
MAR 11	CR 75	DECON	1450	6	7.4
MAR 13	CR 78	DECON	3522	21	10.7
MAR 14	CR 84	SORTER	2486	7	5.1
			1761	3	3.1
MAR 15	CR 84	SORTER	17172	71	7.4
MAR 16	CR 87	DECON	855	10	21.0
			907	11	21.8
MAR 16	CR 87	SORTER	528	12	40.8
MAR 17	CR 89	DECON	1010	14	24.9

TABLE 31 SAMPLE BOX ASSAY DATA

DATE	SAMPLE CODE #	SAMPLE BOX ACTIVITY (BQ/KG)
FEB 17	CR 15A	445
FEB 18	CR 17A	2128
FEB 21	CR 22A	208
FEB 22	CR 26A	167
FEB 23	CR 27A	108
FEB 24	CR 31A	582
FEB 25	CR 36A	225
FEB 25	CR 35B	341
FEB 27	CR 41A	232
FEB 28	CR 45B	303
MAR 1	CR 47A	158
MAR 1	CR 48B	327
MAR 2	CR 51A	105
MAR 2	CR 51B	240
MAR 3	CR 56A	210
MAR 3	CR 56B	152
MAR 4	CR 57A	122
MAR 4	CR 57B	293
MAR 6	CR 59A	167
MAR 6	CR 59B	327
MAR 7	CR 63A	214
MAR 7	CR 67B	77
MAR 8	CR 67A	69
MAR 8	CR 63B	259
MAR 9	CR 69A	126
MAR 9	CR 69B	218
MAR 10	CR 72A	114
MAR 10	CR 72B	293
MAR 11	CR 75A	208
MAR 11	CR 75B	308
MAR 13	CR 78A	177
MAR 13	CR 78B	1015
MAR 14	CR 83A	109
MAR 14	CR 84B	109
MAR 15	CR 84A	423
MAR 15	CR 84B	758
MAR 16	CR 87A	182
MAR 16	CR 87B	344
=====		
AVERAGE		320

TABLE 32 RADIOCHEMICAL ANALYSIS OF SOIL SAMPLES

SAMPLE	DATE	PU-238 (PCI/GM)	PU-239 (PCI/GM)	AM-241 (PCI/GM)	TOTAL TRU (PCI/GM)
SORTER CLEAN	2/27/89	0.36	20.0	3.30	23.7
	3/1/89	0.25	11.0	1.40	12.7
	3/7/89	0.49	22.0	2.00	24.5
	3/8/89	0.27	11.0	1.60	12.9
	3/10/89	0.35	16.0	2.50	18.9
	3/11/89	0.12	5.0	0.63	5.8
	3/13/89	0.18	8.8	1.30	10.3
	2/27/89	0.16	8.0	1.20	9.4
DECON CLEAN	3/1/89	0.10	5.2	0.60	5.9
	3/7/89	0.12	4.6	0.40	5.1
	3/8/89	0.11	5.0	0.50	5.6
	3/10/89	0.11	4.0	0.65	4.8
	3/11/89	0.16	8.6	1.00	9.8
	3/15/89	0.24	5.6	0.42	6.3
=====					
SORTER CLEAN AVERAGE		0.29	13.4	1.82	15.5
DECON CLEAN AVERAGE		0.14	5.9	0.68	6.7
SORTER/DECON AVERAGE		0.22	9.6	1.25	11.1

TABLE 33 - SAMPLES COUNTED WITH GERMANIUM DETECTOR

SAMPLE DATE	LOCATION	SAMPLES WITH HOT PARTICLES		SAMPLES WITH HOT PARTICLES REMOVED		REMARKS
		DAVIDSON CONCENTRATION (PCI/GM)	GRID CONCENTRATION (PCI/GM)	DAVIDSON CONCENTRATION (PCI/GM)	GRID CONCENTRATION (PCI/GM)	
3/2/89	DECON	16.1	12.0	14.2	11.6	
3/3/89	DECON	20.6	NA	13.8	16.4	
3/6/89	DECON	6.4	< 7.0	4.0	7.1	
3/9/89	SORTER	20.1	< 6.3	14.0	13.1	
3/9/89	SORTER	18.1	16.1	NA	12.7	
3/10/89	DECON	5.6	< 7.4	10.6	12.0	
3/11/89	DECON	17.6	21.3	18.8	< 7.2	
3/13/89	SORTER	7.7	< 7.8			
3/14/89	DECON	8.7	< 6.7			
3/14/89	DECON	22.4	27.7	14.4	< 7.2	CONCENTRATE
3/15/89	SORTER	13.0	< 6.9			
3/15/89	DECON	2.4	< 5.6	4.6	< 6.9	
3/16/89	DECON	7.9	12.4	6.2	NA	
3/16/89	DECON	1.4	4.0			
=====						
AVERAGE (PCI/GM)		12.0	10.9	11.2	10.5	
AVERAGE (BQ/KG)		444	402	414	387	
# OF SAMPLES IN AV		14	13	9	9	

TABLE 34 - Particle Size vs Activity
Johnston Atoll 1989

Sample ID: Feed 3/4/89

Date: 3/10/89

Technician: A.J. Wilde

Sieve Mesh	Micron Range	Weight on Sieve gm	Counts in ROI #2 8-42	Counts in ROI #3 42-78	Area Under Peak in ROI #3	pCi	pCi/gm	% of Total Activity
*	As Sampled	*	397	1487	1351	1398.29	2.24	*
10	> 2,000	178	107	221	79.16	53.04	0.30	3.06%
20	850-2,000	172	124	426	352	232.32	1.35	13.38%
50	300-850	157	256	818	534.3	347.30	2.21	20.01%
100	150-300	93	407	1427	1242	720.36	7.75	41.50%
200	75-150	11	132	269	139.5	68.36	6.21	3.94%
325	45-75	8	421	613	520.5	255.05	31.88	14.69%
Pan	< 45	6	97	216	123.5	59.28	9.88	3.42%
Total		625			2990.96	1735.69	2.78	*

TABLE 35 - Particle Size vs Activity
Johnston Atoll 1989

Sample ID: Feed 3-10-89

Date: 3-15-89

Technician: A. J. Wilde

Sieve Mesh	Micron Range	Weight on Sieve gm	Counts in ROI #2 8-42	Counts in ROI #3 42-78	Area Under Peak in ROI #3	pCi	pCi/gm	% of Total Activity
*	As Sampled	*	2342	10887	9240.5	9563.92	12.94	*
10	> 2,000	432	53	304	236.17	188.94	0.44	0.92%
20	850-2,000	99	60	169	107.34	63.33	0.64	0.31%
50	300-850	102	8446	39271	33227.67	19604.33	192.20	95.97%
100	150-300	57	133	347	162	89.10	1.56	0.44%
200	75-150	35	144	485	411	209.61	5.99	1.03%
325	45-75	4	129	384	303.83	148.88	37.22	0.73%
	< 45	10	139	270	251.5	123.24	12.32	0.60%
Total		739			34699.51	20427.41	27.64	

TABLE 36 - Particle Size vs Activity
Johnston Atoll 1989

Sample ID: Feed 3-15-89

Date: 3-18-89

Technician: A.J. Wilde

Sieve Mesh	Micron Range	Weight on Sieve gm	Counts in ROI #2 8-42	Counts in ROI #3 42-78	Area Under Peak in ROI #3	pCi	pCi/gm	% of Total Activity
*	As Sampled	*	218	739	683.5	707.42	1.05	*
10	> 2,000	280	50	94	0	0.00	0.00	0.00%
20	850-2,000	100	39	198	93.17	54.97	0.55	7.85%
50	300-850	159	244	903	526.83	342.44	2.15	48.89%
100	150-300	85	141	615	386.83	220.49	2.59	31.48%
200	75-150	25	92	302	86.17	43.95	1.76	6.27%
325	45-75	7	60	183	10.33	5.06	0.72	0.72%
Pan	< 45	15	85	209	67.17	33.59	2.24	4.79%
Total		671			1170.5	700.50	1.04	

TABLE 37 - Particle Size vs Activity
Johnston Atoll 1989

Sample ID: Clean Pile, Decon Plant 3/4/89

Date: 3/10/89

Technician: A.J. Wilde

Sieve Mesh	Micron Range	Weight on Sieve gm	Counts in ROI #2 8-42	Counts in ROI #3 42-78	Area Under Peak in ROI #3	pCi	pCi/gm	% of Total Activity
*	As Sampled	*	578	1229	908	939.78	1.56	*
10	> 2,000	153	127	188	46.16	29.54	0.19	7.43%
20	850-2,000	152	125	166	0	0.00	0.00	0.00%
50	300-850	187	124	282	47.67	32.42	0.17	8.15%
100	150-300	73	157	246	116.5	65.24	0.89	16.41%
200	75-150	33	110	213	0	0.00	0.00	0.00%
325	45-75	2	273	583	447.3	214.70	107.35	54.00%
Pan	< 45	4	282	328	116	55.68	13.92	14.00%
Total		604			773.63	397.58	0.66	

TABLE 38 - Particle Size vs Activity
Johnston Atoll 1989

Sample ID: Clean 3-10-89

Date: 3-18-89

Technician: A.J. Wilde

Sieve Mesh	Micron Range	Weight on Sieve gm	Counts in ROI #2 8-42	Counts in ROI #3 42-78	Area Under Peak in ROI #3	pCi	pCi/gm	% of Total Activity
*	As Sampled	*	243	776	381.33	394.68	0.55	*
10	> 2,000	127	37	120	0	0.00	0.00	0.00%
20	850-2,000	165	42	123	0	0.00	0.00	0.00%
50	300-850	259	32	227	17.34	12.83	0.05	0.61%
100	150-300	107	561	3465	2903.83	1713.26	16.01	81.49%
200	75-150	47	103	547	380.5	205.47	4.37	9.77%
Total			721		3644.34	2102.40	2.92	

TABLE 39 - Particle Size vs Activity
Johnston Atoll 1989

Sample ID: Sorter Clean Pile 3-15-89

Date: 3-18-89

Technician: A.J. Wilde

Sieve Mesh	Micron Range	Weight on Sieve gm	Counts in ROI #2 8-42	Counts in ROI #3 42-78	Area Under Peak in ROI #3	pCi	pCi/gm	% of Total Activity
*	As Sampled	*	207	593	463.5	479.72	0.69	*
10	> 2,000	449	49	143	1.17	1.13	0.003	0.26%
20	850-2,000	66	92	159	103.5	56.93	0.86	13.17%
50	300-850	82	127	406	202.5	115.43	1.41	26.71%
100	150-300	68	200	764	461.83	258.62	3.80	59.85%
200	75-150	16	77	208	0	0.00	0.00	0.00%
	45-75	7	36	129	0	0.00	0.00	0.00%
Pan	< 45	11	94	185	0	0.00	0.00	0.00%
Total			699		769	432.11	0.62	

TABLE 40 - Particle Size vs Activity
Johnston Atoll 1989

Sample ID: Divert 3/4/89

Date: 3/10/89

Technician: A.J. Wilde

Sieve Mesh	Micron Range	Weight on Sieve gm	Counts in ROI #2 8-42	Counts in ROI #3 42-78	Area Under Peak in ROI #3	pCi	pCi/gm	% of Total Activity
*	As Sampled	*	18239	91944	78007	80737.25	163.11	*
10	> 2,000	95	68814	218004	189625	109982.50	1157.71	98.72%
20	850-2,000	145	193	363	54.7	34.46	0.24	0.03%
50	300-850	114	243	587	284.8	170.88	1.50	0.15%
100	150-300	88	164	498	337.7	195.87	2.23	0.18%
200	75-150	42	356	968	678.2	359.45	8.56	0.32%
325	45-75	10	808	1567	1308	640.92	64.09	0.58%
Pan	< 45	1	192	207	52	25.48	25.48	0.02%
Total		495			192340.4	111409.55	225.07	

TABLE 41 - Particle Size vs Activity
Johnston Atoll 1989

Sample ID: Divert 3-10-89

Date: 3-16-89

Technician: A.J. Wilde

Sieve Mesh	Micron Range	Weight on Sieve gm	Counts in ROI #2 8-42	Counts in ROI #3 42-78	Area Under Peak in ROI #3	pCi	pCi/gm	% of Total Activity
*	As Sampled	*	17261	61917	53962	55850.67	94.02	*
10	> 2,000	164	74	196	41.83	27.19	0.17	0.12%
20	850-2,000	113	120	205	143.33	86.00	0.76	0.39%
50	300-850	177	8100	37180	32468.67	21429.32	121.07	95.99%
100	150-300	84	106	275	188.67	107.54	1.28	0.48%
200	75-150	52	270	672	622.67	336.24	6.47	1.51%
325	45-75	2	81	169	156.67	75.20	37.60	0.34%
	< 45	2	247	602	546.5	262.32	131.16	1.18%
Total		594			34168.34	22323.82	37.58	

TABLE 43 - Particle Size vs Activity
Johnston Atoll 1989

Sample ID: Concentrate 3/4/89

Date: 3/10/89

Technician: A.J. Wilde

Sieve Mesh	Micron Range	Weight on Sieve gm	Counts in ROI #2 8-42	Counts in ROI #3 42-78	Area Under Peak in ROI #3	pCi	pCi/gm	% of Total Activity
*	As Sampled	*	5617	26467	21965	22733.78	29.26	*
10	> 2,000	0	0	0	0	0.00	0.00	0.00%
20	850-2,000	5	247	103	0	0.00	0.00	0.00%
50	300-850	397	58891	268827	237626	199605.84	502.79	72.14%
100	150-300	329	17131	84988	73104	58483.20	177.76	21.14%
200	75-150	40	11665	39604	35367	18567.68	464.19	6.71%
325	45-75	6	529	321	81.8	40.08	6.68	0.01%
Pan	< 45	0	0	0	0	0.00	0.00	0.00%
Total		777			346179	276697	356.11	

TABLE 42 - Particle Size vs Activity
Johnston Atoll 1989

Sample ID: Divert 3-15-89

Date: 3-19-89

Technician: A.J. Wilde

Sieve Mesh	Micron Range	Weight on Sieve gm	Counts in ROI #2 8-42	Counts in ROI #3 42-78	Area Under Peak in ROI #3	pCi	pCi/gm	% of Total Activity
*	As Sampled	*	151	716	598.83	619.79	1.15	*
10	> 2,000	155	42	132	0	0.00	0.00	0.00%
20	850-2,000	107	53	129	0	0.00	0.00	0.00%
50	300-850	165	83	254	0	0.00	0.00	0.00%
100	150-300	79	58	228	43	24.51	0.31	7.06%
200	75-150	27	70	174	50.67	25.84	0.96	7.44%
325	45-75	2	40	137	7.5	3.60	1.80	1.04%
	< 45	4	541	765	598.83	293.43	73.36	84.47%
Total		539			700	347.38	0.64	

TABLE 44 - Particle Size vs Activity
Johnston Atoll 1989

Sample ID: Concentrate 3-10-89

Date: 3-16-89

Technician: A.J. Wilde

Sieve Mesh	Micron Range	Weight on Sieve gm	Counts in ROI #2 8-42	Counts in ROI #3 42-78	Area Under Peak in ROI #3	pCi	pCi/gm	% of Total Activity
*	As Sampled	*	448	1296	741	766.94	1.20	*
10	> 2,000	0	0	0	0	0.00	0.00	0.00%
20	850-2,000	4	53	143	50.5	24.75	6.19	0.73%
50	300-850	402	953	4444	3648.5	2882.32	7.17	84.79%
100	150-300	208	114	293	243.67	168.13	0.81	4.95%
200	75-150	22	172	424	331.5	169.07	7.68	4.97%
325	45-75	1	197	391	323.17	155.12	155.12	4.56%
Pan	< 45	0	0	0	0	0.00	0.00	0.00%
Total		637			4597.34	3399.38	5.34	

TABLE 45 - Particle Size vs Activity
Johnston Atoll 1989

Sample ID: Concentrate 3-15-89

Date: 3-20-89

Technician: A.J. Wilde

Sieve Mesh	Micron Range	Weight on Sieve gm	Counts in ROI #2 8-42	Counts in ROI #3 42-78	Area Under Peak in ROI #3	pCi	pCi/gm	% of Total Activity
*	As Sampled	*	1238	4525	3649.34	3777.07	4.87	*
10	> 2,000	0	0	0	0	0.00	0.00	0.00%
20	850-2,000	3	50	141	23.83	11.68	3.89	0.04%
50	300-850	581	2247	4166	3321.17	2989.05	5.14	10.28%
100	150-300	189	9348	47804	41569.5	24110.31	127.57	82.90%
200	75-150	2	2012	5122	4024.3	1971.91	985.95	6.78%
325	45-75	0	0	0	0	0.00	0.00	0.00%
Pan	< 45	0	0	0	0	0.00	0.00	0.00%
Total		775			48938.8	29082.95	37.53	

TABLE 46 - Particle Size vs Activity
Johnston Atoll 1989

Sample ID: Re-Concentrate 3-14-89

Date: 3-20-89

Technician: A.J. Wilde

Sieve Mesh	Micron Range	Weight on Sieve gm	Counts in ROI #2 8-42	Counts in ROI #3 42-78	Area Under Peak in ROI #3	pCi	pCi/gm	% of Total Activity
*	As Sampled	*	94670	415005	343934	355971.69	465.32	*
10	> 2,000	0	0	0	0	0.00	0.00	0.00%
20	850-2,000	3	81	137	1.34	0.66	0.22	0.00%
50	300-850	586	15688	76383	65535.83	58982.25	100.65	60.01%
100	150-300	166	17223	38808	32197.33	20928.26	126.07	21.29%
200	75-150	7	32151	41047	36964.67	18112.69	2587.53	18.43%
325	45-75	1	177	277	264.67	127.04	127.04	0.13%
Pan	< 45	2	205	279	279	133.92	66.96	0.14%
Total		765			135242.84	98284.82	128.48	

TABLE 47 - RADIOACTIVE CONTENT OF CONCENTRATE CONTAINERS

SAMPLE INCRE- MENT	CONCENTRATE BOX 1		CONCENTRATE BOX 2		CONCENTRATE BOX 3		CONCENTRATE BOX 4		CONCENTRATE BOX 5		CONCENTRATE BOX 6		CONCENTRATE BOX 7		CONCENTRATE BOX 8		CONCENTRATE BOX 9		CONCENTRATE BOX 10		CONCENTRATE BOX 11		CONCENTRATE BOX 12		CONCENTRATE BOX 13		
	nCi/g	uCi	nCi/g	uCi	nCi/g	uCi	uCi	uCi	nCi/g	uCi	nCi/g	uCi	nCi/g	uCi	nCi/g	uCi	nCi/g	uCi	nCi/g	uCi	nCi/g	uCi	nCi/g	uCi	nCi/g	uCi	
1	0.00	0	0.07	3	0.04	2	0.03	3	0.16	13	0.43	36	0.00	0	0.11	9	0.15	18	0.16	20	0.09	7	0.14	11	0.65	80	
2	0.00	0	0.09	4	0.04	3	0.00	0	0.25	10	0.18	8	0.00	0	0.06	2	0.04	1	0.16	26	0.28	12	0.16	6	0.77	32	
3	0.00	0	0.02	1	0.14	6	0.04	2	0.25	10	0.22	9	0.00	0	0.14	6	0.15	6	0.02	1	0.17	7	0.28	12	0.82	34	
4	0.25	10	0.03	3	0.16	13	0.00	0	0.11	5	0.11	13	0.00	0	0.08	3	0.15	6	0.12	5	0.05	2	0.10	4	0.69	28	
5	0.21	18	0.10	4	0.07	3	0.01	1	0.12	5	0.00	0	0.06	2	0.03	1	0.07	3	0.14	6	0.23	10	0.04	3	0.47	19	
6	0.29	36	0.18	15	0.24	10	0.05	2	0.13	5	0.06	3	0.00	0	0.16	7	0.04	2	0.28	11	0.00	0	0.35	14	0.76	31	
7	0.34	7	0.04	3	0.10	9	0.03	2	0.23	10	0.11	4	0.20	8	0.00	0	0.03	1	0.29	12	0.16	7	0.51	21	0.73	30	
8	0.91	19	0.10	12	0.08	3	0.00	0	0.34	14	0.10	4	0.12	10	0.08	3	0.00	0	0.29	12	0.27	22	0.28	11	0.21	9	
9	1.03	127	0.09	4	0.22	9	0.00	0	0.16	13	0.04	2	0.07	5	0.07	6	0.31	13	0.49	20	0.25	10	0.28	11	0.58	48	
10	0.78	64	0.04	5	0.13	5	0.06	5	0.08	3	0.04	3	0.05	4	0.10	8	0.36	15	0.20	8	0.07	3	0.21	18	0.76	31	
11	0.50	41	0.08	6	0.16	13	0.12	5	0.04	3	0.19	8	0.11	4	0.02	1	0.07	3	0.33	13	0.06	5	0.40	16	0.35	15	
12	0.19	16	0.02	1	0.16	14	0.07	3	0.03	4	0.05	4	0.14	6	0.11	5	0.12	5	0.19	8	0.16	7	0.36	15	0.30	12	
13	0.21	34	0.17	7	0.22	9	0.14	6	0.05	4	0.14	12	0.17	14	0.08	3	0.18	15	0.21	9	0.25	21	0.52	21	0.38	16	
14	0.28	35	0.13	5	0.18	15	0.19	15	0.11	14	0.07	3	0.10	8	0.17	7	0.29	12	0.37	30	0.12	5	0.50	20	0.35	14	
15	0.11	5	0.29	12	0.23	9	0.23	10	0.23	9	0.08	3	0.04	2	1.59	65	0.14	6	0.25	10	0.42	17	0.46	38	0.65	27	
16	0.32	13	0.12	5	0.17	7	0.22	18	0.13	11	0.06	5	0.00	0	0.25	21	0.14	11	0.39	16	0.14	6	0.58	24	0.50	20	
17	0.24	10	0.05	2	0.10	4	0.26	21	0.14	11	0.11	4	0.00	0	0.22	9	0.28	11	0.34	14	0.46	19	0.50	21	0.71	29	
18	0.19	8	0.05	2	0.26	11	0.33	14	0.20	8	0.20	8	0.02	1	0.13	6	0.46	19	0.24	10	0.21	9	0.45	18	0.81	33	
19	0.12	5	0.17	7	0.16	7	0.27	22	0.17	20	0.07	3	0.03	3	0.27	11	0.27	11	0.47	19	0.30	12	0.35	15	0.41	17	
20	0.59	12	0.11	4	0.27	22	0.28	12	0.31	13	0.12	10	0.06	2	0.37	15	0.29	12	0.32	13	0.24	10	0.25	10	0.63	26	
21	0.14	3	0.43	18	0.41	17	0.29	12	0.32	13	0.09	4	0.17	21	0.07	3	0.16	6	0.16	7	0.39	16	0.37	15	0.60	25	
22	0.18	7	0.36	15	0.18	7	0.16	13	0.42	34	0.22	18	0.17	7	0.27	11	0.18	7	0.18	7	0.51	21	0.42	17	0.48	20	
23	0.09	4	0.21	9	0.17	7			0.06	2	0.20	16	0.21	9	0.29	12	0.34	14	0.28	12	0.30	12	0.48	20	0.56	23	
24	0.13	5			0.15	6					0.31	13	0.27	11	0.26	21	0.37	15	0.28	12	0.34	14	0.33	14	0.66	27	
25	0.07	3			0.09	4					0.13	5			0.22	9	0.20	17	0.41	17	0.30	12	0.62	26	0.34	14	
26	0.21	8			0.08	3									0.22	9	0.19	8	0.48	20	0.52	21	0.41	17	0.33	13	
27					0.14	6									0.17	7	0.27	11	0.55	23	0.36	15	0.46	19	0.40	16	
28					0.09	4									0.31	13	0.18	7			0.27	11	0.55	45	0.54	44	
29					0.08	3									0.17	7	0.16	6			0.24	10	0.39	16	0.44	18	
30															0.20	8	0.11	4			0.22	9	0.56	23	0.76	31	
31																					0.15	6			0.57	24	
32																										0.51	21
AVERAGE TOTAL	0.28	490	0.13	147	0.16	230	0.13	164	0.17	235	0.13	197	0.08	5	0.21	289	0.19	266	0.28	360	0.24	337	0.38	523	0.55	827	

TABLE 47 - RADIOACTIVE CONTENT OF CONCENTRATE CONTAINERS

SAMPLE INCRE- MENT	CONCENTRATE BOX 14		CONCENTRATE BOX 15		CONCENTRATE BOX 16		CONCENTRATE BOX 17		CONCENTRATE BOX 18		CONCENTRATE BOX 19		CONCENTRATE BOX 20		CONCENTRATE BOX 21		CONCENTRATE BOX 22		CONCENTRATE BOX 23		CONCENTRATE BOX 24		CONCENTRATE BOX 25		CONCENTRATE BOX 26		
	nCi/g	uCi	nCi/g	uCi	nCi/g	uCi	nCi/g	uCi	nCi/g	uCi	nCi/g	uCi	nCi/g	uCi	nCi/g	uCi	nCi/g	uCi	nCi/g	uCi	nCi/g	uCi	nCi/g	uCi	nCi/g	uCi	
1	0.16	20	0.28	35	0.25	20	0.25	20	0.19	16	0.08	10	0.31	39	0.35	29	0.38	32	0.12	15	0.23	15	0.86	71	0.72	55	
2	0.24	10	0.30	12	0.44	18	0.10	8	0.29	24	0.02	2	0.35	14	0.34	14	0.24	10	0.29	12	0.36	16	1.38	57	0.75	32	
3	0.26	11	0.35	14	0.49	20	0.17	7	0.15	12	0.09	4	0.40	16	0.24	20	0.17	14	0.29	12	0.09	4	0.81	33	0.72	25	
4	0.21	9	0.36	15	0.41	17	0.06	2	0.39	16	0.00	0	0.27	11	0.17	7	0.28	12	0.24	10	0.17	13	0.52	21	0.51	24	
5	0.28	12	0.56	23	0.36	15	0.30	12	0.18	8	0.05	2	0.29	12	0.15	6	0.17	7	0.28	11	0.27	13	0.58	24	1.00	31	
6	0.37	15	0.34	28	0.68	56	0.16	7	0.23	10	0.08	3	0.17	7	0.20	8	0.23	10	0.14	6	0.34	18	0.31	13	0.35	22	
7	0.29	12	0.20	8	0.43	18	0.08	3	0.19	8	0.12	5	0.47	57	0.26	10	0.16	13	0.53	22	0.26	12	0.14	6	0.31	17	
8	0.36	15	0.54	22	0.49	20	0.22	9	0.15	6	0.15	6	0.30	25	0.12	5	0.36	15	0.44	36	0.23	11	0.28	11	0.36	21	
9	0.41	17	0.33	14	0.32	13	0.07	3	0.20	8	0.14	6	0.35	14	0.12	5	0.16	7	0.67	28	0.34	20	0.42	17	0.36	20	
10	0.50	20	0.33	13	0.44	18	0.04	1	0.15	6	0.18	8	0.45	18	0.38	16	0.59	49	0.17	7	0.32	24	0.48	20	0.85	45	
11	0.31	13	0.17	7	0.85	35	0.31	50	0.21	25	0.11	5	0.40	17	0.34	14	0.61	25	0.17	7	0.16	9	0.34	14	0.29	16	
12	0.48	20	0.41	17	0.65	27	0.11	4	0.37	15	0.18	7	0.30	12	0.55	22	0.52	21	0.07	3	0.39	12	0.30	12	0.41	19	
13	0.63	26	0.18	7	0.55	45	0.16	7	0.24	10	0.11	9	0.42	17	0.42	17	0.31	13	0.26	11	0.56	12	0.39	16	0.62	23	
14	0.63	26	0.54	22	0.46	19	0.21	9	0.22	9	0.10	4	1.45	60	0.37	15	0.20	8	0.42	51	0.14	8	0.34	14	0.60	30	
15	0.56	23	0.59	24	0.43	18	0.30	12	0.12	5	0.36	15	0.65	27	0.46	19	0.37	15	0.19	8	0.55	18	0.00	0	0.55	24	
16	0.46	19	0.47	19	0.30	12	0.26	11	0.38	15	0.33	14	0.35	14	0.35	15	0.20	8	0.40	16	0.56	23	0.01	0	0.41	17	
17	0.48	20	0.70	58	0.34	14	0.17	7	0.36	15	0.27	11	0.56	23	0.33	14	0.22	9	0.17	7	0.68	28	0.00	0	0.30	12	
18	0.39	32	0.60	25	0.30	12	0.18	7	0.35	14	0.17	7	0.27	11	0.33	14	0.41	17	0.20	16	0.89	36	0.48	20	0.34	14	
19	0.50	21	0.39	16	0.37	15	0.28	12	0.30	12	0.30	12	0.20	8	0.63	26	0.32	13	0.33	13	1.86	76	0.00	0	0.27	11	
20	0.47	19	0.38	16	0.85	35	0.40	16	0.33	14	0.22	9	0.23	9	0.56	23	0.33	14	0.32	13	1.86	77	1.05	43	0.83	34	
21	0.47	19	0.34	14	0.81	33	0.34	14	0.19	8	0.23	9	0.17	7	0.35	14	0.23	10	0.33	13	2.10	86	0.60	25	0.67	27	
22	0.52	43	0.41	17	0.65	27	0.21	9	0.22	9	0.18	7	0.44	36	0.68	28	0.27	11	0.35	15	2.16	89	0.85	35	0.63	26	
23	0.33	14	0.34	14	0.62	25	0.12	5	0.26	11	0.22	9	0.17	7	0.50	21	0.24	10	0.21	9	2.13	87	0.47	19	0.54	22	
24	0.24	10	0.34	14	1.22	50	0.15	6	0.16	6	0.15	6	0.15	6	0.45	18	0.24	10	0.18	8	2.54	104	0.70	29	0.49	20	
25	0.52	22	0.30	12	0.51	21	0.16	6	0.26	11	0.14	6	0.16	7	0.33	14	0.55	23	0.30	12	2.25	92	0.86	36	0.29	12	
26	0.45	18	0.38	16	0.37	15	0.19	8	0.43	36	0.80	33	0.23	10	0.36	15	0.56	23	0.25	10	2.28	94	0.76	62	0.43	53	
27	0.46	19	0.31	13	0.43	35	0.17	7	0.22	9	0.52	22	0.37	15	0.50	20	0.31	13	0.21	9	1.98	81	0.46	19	0.65	27	
28	0.41	17	0.66	27			0.13	5	0.25	10	0.28	12			0.44	18	0.19	8	0.31	13	2.77	114	0.63	26	0.56	23	
29	0.35	14	0.20	8			0.20	8	0.22	9	0.25	10			0.38	16	0.28	11	0.22	9	2.27	93	0.46	19	0.42	17	
30	0.36	15	0.31	13			0.29	12			0.25	10			0.35	14	0.24	10	0.50	20			0.63	26	0.40	16	
32	0.41	17	0.31	13							0.25	10			0.39	16	0.29	12	0.19	8			0.77	32	0.36	15	
33																	0.25	10							0.29	12	
34																	0.25	10							0.25	10	
45																										0.22	9
36																										0.57	24
37																										0.42	17
AVERAGE TOTAL	0.40	565	0.38	555	0.52	655	0.19	289	0.25	358	0.21	274	0.37	500	0.37	492	0.31	471	0.28	429	1.06	1288	0.51	719	0.49	821	

TABLE 48 - PARTICLES IN FEED STREAM

DATE	AM-241 ACTIVITY (NCI)	PARTICLE DESCRIPTION	COMMENTS
2/16/89	469	FOLDED METAL FOIL	MAGNETIC
2/22/89	1128	METAL FOIL AND ROCK	MAGNET WITH POLES
2/22/89	98	GREY METAL	
2/25/89	919	GREY METAL FOIL	

TABLE 49 - PARTICLES IN WASTE CONCENTRATE STREAM

DATE 1989	ACTIVITY IN NCI OF Am -241	MESH SIZE	PARTICLE DESCRIPTION	COMMENTS
22 Feb	157.0			Opened system for Repair
23 Feb	329.0	100	Black fleck	From Container
	83.0	200	Black speck	From Container
	52.0	50	Black sphere	From Container
24 Feb	43.5	325	Tiny black speck	Tray sample
	19.8		Black ceramic fragment	Tray sample
	25.9	50	Black fragment	Tray sample
	15.1	100	Black speck	Tray sample
	7.1	50	Black speck	
	25.0	50	Black Sphere	

TABLE 50 PARTICLES IN DIVERSION STREAM

DATE 1989	ACTIVITY IN NC1 OF Am -241	MESH SIZE	PARTICLE DESCRIPTION	COMMENTS
21 Feb	7.3		Burned plastic froth	Low density
22 Feb	65.3			Tray Sample
23 Feb	110.7			
	47.7		Gray metal hollow sphere	
	383.1		Spongy sphere porous gray	
	277.4			
	158.6		Particle on a rock	
24 Feb	566.8		Particle imbedded in rock	
	82.7	50	Sphere on a rock	
	15.6			Tray sample
27 Feb	198.7		Hollow sphere	Magnetic
	37.0	100	Particle on a rock	
	301.9		Cluster of wet coral particles	
01 Mar	96.3		Hollow sphere - low density	
	60.6		Small sphere on coral rock	
02 Mar	263.0		Small sphere on coral rock	
	55.5		Low density metal foil	
	19.0	200	Small speck on coral rock	
	109.9	100	Metal sphere on rock	
	348.1		Rusy metal in coral matrix	
10 Mar	9554.5		Metal with fine sand imbedded	
	83.4		Low density	
	768.8		Low density large metal fragment	

TABLE 51 PARTICLES DIVERTED TWICE (RECYCLE OF DIVERTED MATERIAL)

DATE 1989	ACTIVITY IN NC1 OF Am -241	MESH SIZE	PARTICLE DESCRIPTION	COMMENTS
11 Mar	80.3			
	24.4			
	102.8			
	22.6			
	794.4			
14 Mar	480.9	100	Particle on a rock	
	236.7	50	Low density metal fragment	
	2414.4		Metal foil packed with coral	
	148.9	50	Very black oxide metal fragment	
	67.9	50	Very black oxide metal fragment	

TABLE 52 - PARTICLES FOUND IN DECON CLEAN STREAM WHICH AVOIDED DIVERSION

DATE 1989	ACTIVITY IN NC1 OF Am -241	MESH SIZE	PARTICLE DESCRIPTION	COMMENTS
27 Feb	881.4			
	97.1			
	55.2	50	Black sphere	
	37.4	200	Black speck	
28 Feb	66.8			
	43.4	100	Small particle, magnetic	
01 Mar	17.5		Low density metal	Largest particle
02 Mar	478.9	100	Particle on a rock	
	370.0	50	Grey metal flake	
03 Mar	29.6			
	38.9		Small white rock - No metal visible	
	21.5	200	Tiny black sphere	Very mobile
	6.7	325	Tiny black sphere	Very mobile
	16.5	100		
	38.9			
04 Mar	101.6		White volcanic ash, round	Low density
	87.5			
	18.0	100	Single dry black particle	
	35.9	100	Grey metal flake	
	12.6	200	Grey metal sphere	Very mobile
	45.9	50		Not mobile
	20.8	<325	Tiny, not visible in plastic dish	
	51.5			
06 Mar	79.2			
	78.5			
	7.6			
	41.9			
	54.1	50	Metal sphere	Very mobile
	78.5		Tiny metal in rock	Very mobile
	79.2	100	Small sphere	Very mobile
	13.4	50	Grey oblong metal	
	39.2	50	Small sphere	Very mobile
	96.6	100	Small black flake	
	33.7	50	thin grey metal	
	60.6	50	Grey flake	
	124.5	50	Grey and white dot	Single
	30.8	200	Tiny black speck	Single
07 Mar	38.9		Grey sphere	Mobile
	6.6		Tiny dot, not visible in dish	
	40.5	100	Small black dot	Single
	8.0		Hollow sphere	
	9.3		Grey metal flake	
	43.4	50	Grey metal	
	13.6	100	Tiny grey sphere	Very mobile
09 Mar	345.8		Round white cinder	Very mobile
	26.9		Fine copper wire	Rolls
11 Mar	53.3		Black dot on rock	Very mobile
	64.7		Metal foil with coral	Low density
	115.8	100	Metal fragment	Black Dot
	786.9		Cinder with particle	Large & ligh
	23.9	325	Tiny particle	Barely visible
	5.8			
	15.1	100		
	31.9	50	Black particle	Very mobile
	7.2		Grey oblong flake	
	211.6			
	38.6		Small black particle	Single
	370.3		Metal cuboid	Low density
	45.9		Black particle	Single
	124.4	50	Metal sphere	Very Mobile
13 Mar	44.8	100	Grey metal sphere	Very Mobile
	185.7		Grey rectangle	Not mobile
	52.1	100	Metal sphere	Mobile
	85.5		Dark metal chunk	Very mobile
	52.1	100	Small sphere	
	196.6	50	Grey fragment	Very mobile
	100.2	50	Grey metal sphere	
	45.6	50	Black metal fragment	Mobile

TABLE 52 - PARTICLES FOUND IN DECON CLEAN STREAM WHICH AVOIDED DIVERSION

DATE 1989	ACTIVITY IN NCi OF Am -241	MESH SIZE	PARTICLE DESCRIPTION	COMMENTS
	28.8	100	Grey sphere	
	247.9		Fly ash - low density	Grey
	10,317.6		Large low density	
	36.6	200	Black speck	
	1,560.8		Fly ash - dark on white	
	44.4	50	Round metal	Very mobile
	62.8	50	Round black flake	Very mobile
	45.5	200	Black speck	
	22.7	200	Small black speck	
	73.4	100	Small black speck	
14 Mar	16.2	100	Small black sphere	Extremely mobile
	24.7	100	Black speck	
	12.1	200	Small black speck	
	19.7		Green, fine copper wire	

TABLE 53 - PARTICLES FOUND IN SORTER CLEAN STREAM WHICH AVOIDED DIVERSION

DATE 1989	ACTIVITY IN NC1 OF Am -241	MESH SIZE	PARTICLE DESCRIPTION	COMMENTS
18 Feb	31.6			
25 Feb	126.4			
27 Feb	10.0		Small sphere, very mobile, black	
	54.9			
	108.3			
	30.2			
28 Feb	10.9			
01 Mar	40.0			
	127.2		50 Black metal mobile sphere	
	16.3		325 Tiny black speck on rock	
	21.9			
	18.6			
02 Mar	49.8			
03 Mar	83.2			
	33.1			
	29.6			
	16.2			
	29.5			
	21.8			
	39.1			
	9.2			
	11.4			
04 Mar	43.5			
06 Mar	170.2			
07 Mar	157.9			
	28.9			
	15.8			
	28.4			
09 Mar	350		Sphere imbedded in rock	
	200.8		Non spherical	
	1934.6			
	72.9			
	114.6			
	46.7			
	25.4			
	42.1			
	50.2			
	15.3			
	788.6		Crumpled sheet of light metal	
11 Mar	13.8			
	198.9			
	42.6			
	53.3			
	64.7			
	115.8			
	786.9			
13 Mar	31.3		Small sphere stuck on rock	
	219.4		100 Small sphere rusted to rock	
	16.1		200 Tiny speck on white rock	
14 Mar	12.1		200 Tiny speck on white rock	
14 Mar	64.1		100 Particles on a rock	
15 Mar	30.5			
16 Mar	1602.3			

TABLE 54 DETERMINATION OF H, THE CLEAN SOIL BACKGROUND COUNT

		CLEAN SOIL BACKGROUND COUNTS																
		ALL COUNTED IN DETECTOR SET B ON THE DECON PLANT																
DATE & CODE #	COUNT TIME & MODE MIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	ARRAY	
FEB 14 CR 7	B 30 CTS	2877	3406	3598	3383	3436	4982	3471	3482	3659	3958	4163	4277	3332	3669	3324	55017	
FEB 16 CR 9	B 10 CTS	935	1055	1208	1092	1196	1526	1092	1051	1226	1001	1263	1343	1040	1091	1046	17165	
CR 90	B 2 CTS	222	254	281	266	233	363	266	261	284	297	273	318	284	265	255	4122	
		=====																
2520 SEC	TOTAL CTS	4034	4715	5087	4741	4865	6871	4829	4794	5169	5256	5699	5938	4656	5025	4625	76304	
	H (CPS)	1.60	1.87	2.02	1.88	1.93	2.73	1.92	1.90	2.05	2.09	2.26	2.36	1.85	1.99	1.84	30.28	
	STD DEV	0.14	0.15	0.15	0.15	0.14	0.18	0.15	0.15	0.16	0.16	0.15	0.16	0.15	0.15	0.15	0.59	

TABLE 55 - EXAMPLES OF TRAY COUNTING USING ACTUAL SAMPLES TO DEMONSTRATE THE EFFECT OF DIFFERENT METHODS FOR BACKGROUND SUBTRACTION AND FOR EVALUATING THE MINIMUM DETECTABLE COUNT RATE (MDCR)

DATE & CODE #		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	ARRAY
FEB 16	B 10	2.45	3.47	2.79	2.80	2.61	3.91	3.96	2.49	4.47	5.44	4.10	5.19	3.97	13.80	3.41	64.85
CR 14	C 10	1	1	1	0	1	1	2	0	3	3	2	2	2	11	1	31.00
DECON	B-H	0.85	1.60	0.77	0.91	0.68	1.18	2.05	0.59	2.42	3.35	1.84	2.83	2.13	11.80	1.57	34.57
	H	1.60	1.87	2.02	1.88	1.93	2.73	1.92	1.90	2.05	2.09	2.26	2.36	1.85	1.99	1.84	30.28
MDCR	B10 BKG10	0.27	0.31	0.29	0.29	0.35	0.33	0.28	0.34	0.37	0.34	0.37	0.32	0.32	0.53	0.31	1.31
MDCR	B2 BKG 10	0.50	0.59	0.54	0.54	0.52	0.63	0.63	0.51	0.66	0.73	0.64	0.72	0.63	1.13	0.58	2.53

MDCR OF CONVEYOR BELT USING TRAY DATA

10 S CT 600 S BKG	1.64	1.95	1.75	1.75	1.69	2.07	2.08	1.66	2.21	2.44	2.12	2.38	2.09	3.87	1.93	8.42
10 S CT 10 S BKG	2.10	2.41	2.28	2.25	2.22	2.68	2.53	2.18	2.66	2.86	2.63	2.86	2.51	4.14	2.39	10.16

TRAY COUNTING CONTINUED -MARCH 9 TRAYS

MAR 9	B 2	1.78	2.66	3.83	2.78	2.49	3.22	2.17	2.52	2.59	3.80	3.45	3.04	2.43	2.28	2.25	41.28
CR 69	C 4	0	1	2	0	0	1	0	0	0	2	1	1	0	0	0	8.00
DECON	B-H	0.17	1.06	2.23	1.17	0.89	1.62	0.57	0.92	0.99	2.20	1.85	1.44	0.82	0.68	0.65	10.99
MDCR	B2 BKG 10	0.44	0.52	0.62	0.53	0.51	0.58	0.48	0.51	0.52	0.62	0.59	0.56	0.50	0.49	0.49	2.07

MDCR OF CONVEYOR BELT USING TRAY DATA

10 S CT 600 S BKG	1.40	1.71	2.05	1.75	1.66	1.88	1.55	1.66	1.69	2.04	1.95	1.83	1.63	1.59	1.57	6.74
10 S CT 10 S BKG	1.91	2.22	2.52	2.25	2.19	2.54	2.11	2.19	2.25	2.53	2.49	2.42	2.15	2.15	2.11	8.81

TRAY COUNTING CONTINUED -MARCH 9 TRAYS

MAR 9	B 2	2.46	37.90	6.59	3.48	3.16	3.38	3.14	4.81	3.21	4.20	3.79	7.40	4.36	2.72	2.77	93.37
CR 69	C 4	0	32	4	1	1	1	1	3	1	2	1	3	2	1	1	54.00
SORTER	B-H	0.86	36.30	4.99	1.88	1.56	1.78	1.54	3.21	1.61	2.60	2.19	5.80	2.76	1.12	1.17	63.09
MDCR	B2 BKG 10	0.50	1.86	0.80	0.59	0.57	0.60	0.56	0.69	0.57	0.65	0.62	0.84	0.65	0.53	0.53	3.00

MDCR OF CONVEYOR BELT USING TRAY DATA

10 S CT 600 S BKG	1.64	6.42	2.68	1.95	1.86	1.93	1.86	2.29	1.88	2.14	2.04	2.84	2.18	1.73	1.74	10.10
10 S CT 10 S BKG	2.10	6.57	3.06	2.41	2.35	2.58	2.34	2.70	2.39	2.61	2.56	3.25	2.60	2.26	2.24	11.59

SAMPLE LEGEND:

- B 10 = 10 MINUTE COUNT WITH BACKGROUND COUNTING MODE (CPS)
- C 10 = 10 MINUTE COUNT WITH CALIBRATE COUNTING MODE (CPS)
- H = CLEAN SOIL BACKGROUND (CPS)
- B-H = CLEAN SOIL BACKGROUND SUBTRACTED FROM BACKGROUND COUNTING MODE (CPS)
- MDCR B10 BKG 10 = MINIMUM DETECTABLE COUNT RATE WITH 10 MINUTE COUNT IN BACKGROUND COUNT MODE AND 10 MINUTE CLEAN SOIL BACKGROUND SUBTRACTED
- 10 S CT 600 S BKG = MDCR WITH 10 SEC COUNT IN BACKGROUND MODE AND 600 SEC CLEAN SOIL BACKGROUND SUBTRACTED

TABLE 56 RADIOACTIVE PARTICLE COUNT RATE ANALYSIS
DETECTOR GROUPS OF THREE

DATE & CODE #	COUNT TIME & MODE MIN																
		1	2	9	SUM	2	3	10	SUM	3	4	11	SUM	4	5	12	SUM
FEB 16	B 10	2.45	3.47	4.47	10.38	3.47	2.79	5.44	11.70	2.79	2.80	4.10	9.69	2.80	2.61	5.19	10.59
CR 14	C 10	1	1	3	5.00	1	1	3	5.00	1	0	2	3.00	0	1	2	3.00
DECON	B-H	0.85	3.47	4.47	8.78	3.47	2.79	5.44	11.70	0.92	2.80	4.10	7.82	2.80	2.61	5.19	10.59
	H	1.60	1.87	2.05	5.52	1.87	2.02	2.09	5.98	2.02	1.88	2.26	6.16	1.88	1.93	2.36	6.17
MIN DET	600 S BKG	3.65	4.34	4.93	7.51	4.34	3.90	5.44	7.98	3.90	3.90	4.72	7.26	3.90	3.77	5.31	7.59
MIN DET	2 S BKG	4.69	5.38	5.95	9.29	5.38	5.11	6.39	9.79	5.11	5.04	5.88	9.28	5.04	4.96	6.40	9.54
EXAMPLE FROM MARCH 9, 1989																	
MAR 9	B 2	1.78	2.66	2.59	7.03	2.66	3.83	3.80	10.29	3.83	2.78	3.45	10.06	2.78	2.49	3.04	8.31
CR 69	C 4	0	1	0	1.00	1	2	2	5.00	2	0	1	3.00	0	0	1	1.00
DECON	B-H	0.17	0.79	0.54	1.50	0.79	1.81	1.71	4.32	1.81	0.89	1.19	3.90	0.89	0.56	0.69	2.14
MIN DET	600 S BKG	3.11	3.80	3.76	6.18	3.80	4.57	4.55	7.48	4.57	3.89	4.33	7.40	3.89	3.68	4.07	6.72
MIN DET	2 S BKG	4.28	4.96	5.02	8.25	4.96	5.64	5.65	9.40	5.64	5.03	5.57	9.38	5.03	4.90	5.41	8.86
MAR 9	B 2	2.46	37.90	3.21	43.57	37.90	6.59	4.20	48.69	6.59	3.48	3.79	13.87	3.48	3.16	7.40	14.04
CR 69	C 4	0	32	1	33.00	32	4	2	38.00	4	1	1	6.00	1	1	3	5.00
SORTER	B-H	0.86	36.03	1.16	38.04	36.03	4.57	2.11	42.72	4.57	1.60	1.53	7.71	1.60	1.23	5.04	7.87
MIN DET	600 S BKG	3.66	14.34	4.18	15.38	14.34	5.98	4.78	16.26	5.98	4.35	4.54	8.68	4.35	4.14	6.34	8.74
MIN DET	2 S BKG	4.69	14.69	5.34	16.32	14.69	6.84	5.84	17.23	6.84	5.40	5.73	10.43	5.40	5.26	7.28	10.47

		5	6	13	SUM	6	7	14	SUM	7	8	15	SUM				
FEB 16	B 10	2.61	3.91	3.97	10.49	3.91	3.96	13.80	21.67	3.96	2.49	3.41	9.86				
CR 14	C 10	1	1	2	4.00	1	2	11	14.00	2	0	1	3.00				
DECON	B-H	2.61	3.91	3.97	10.49	3.91	3.96	13.80	21.67	3.96	2.49	3.41	9.86				
	H	1.93	2.73	1.85	6.50	2.73	1.92	1.99	6.64	1.92	1.90	1.84	5.65				
	DET 600 S BKG	3.77	4.61	4.65	7.55	4.61	4.64	8.66	10.85	4.64	3.68	4.30	7.32				
	DET 10 S BKG	4.78	5.60	5.72	9.32	5.60	5.70	9.29	12.25	5.70	4.87	5.55	9.33				

EXAMPLE FROM MARCH 9, 1989																	
MAR 9	B 2	2.49	3.22	2.43	8.13	3.22	2.17	2.28	7.67	2.17	2.52	2.25	6.93				
CR 69	C 4	0	1	0	1.00	1	0	0	1.00	0	0	0	0.00				
DECON	B-H	0.56	0.49	0.58	1.63	0.49	0.25	0.29	1.03	0.25	0.61	0.41	1.28				
MIN DET	600 S BKG	3.68	4.18	3.63	6.65	4.18	3.43	3.53	6.46	3.43	3.70	3.50	6.14				
MIN DET	10 S BKG	4.71	5.26	4.93	8.61	5.26	4.77	4.87	8.61	4.77	4.89	4.95	8.43				
MAR 9	B 2	3.16	3.38	4.36	10.90	3.38	3.14	2.72	9.24	3.14	4.81	2.77	10.72				
CR 69	C 4	1	1	2	4.00	1	1	1	3.00	1	3	1	5.00				
SORTER	B-H	1.23	0.66	2.51	4.40	0.66	1.23	0.72	2.60	1.23	2.91	0.93	5.06				
MIN DET	600 S BKG	4.14	4.29	4.87	7.70	4.29	4.13	3.85	7.09	4.13	5.11	3.88	7.63				
MIN DET	10 S BKG	5.08	5.34	5.90	9.44	5.34	5.29	5.11	9.09	5.29	6.03	5.22	9.57				

SAMPLE LEGEND:

B 10 = 10 MINUTE COUNT WITH BACKGROUND COUNTING MODE (CPS)

C 10 = 10 MINUTE COUNT WITH CALIBRATE COUNTING MODE (CPS)

H = CLEAN SOIL BACKGROUND (CPS)

B-H = CLEAN SOIL BACKGROUND SUBTRACTED FROM BACKGROUND COUNTING MODE (CPS)

MIN DET 600 S BKG = MINIMUM DETECTABLE COUNT RATE WITH 600 SEC CLEAN SOIL BKG SUBTRACTED

TABLE 57 AIR SAMPLE RESULTS

FRONT END LOADER		GRIZZLY DOWNWIND		SORTER PLANT	
DATE	FCI/M3	DATE	FCI/M3	DATE	FCI/M3
2/9	11.10	2/10	394.00	2/17	5.91
2/11	16.40	2/15	6.32	2/18	1.21
2/13	10.70	2/17	0.00	2/23	9.82
2/15	6.30	2/18	1.72	2/25	5.76
2/17	13.90	2/18	0.00	3/1	0.68
2/18	0.00	2/21	13.20	3/2	236.20
2/18	0.00	3/6	0.86	3/3	3.68
2/22	0.00			3/4	0.00
2/24	0.00			3/6	0.00
2/25	0.00			3/7	0.00
2/28	0.00			3/7	0.00
3/2	0.00			3/10	2.29
3/3	0.00				
3/4	147.00				
3/7	7.53				
3/10	1.11				
3/16	0.00				

DECON PLANT		INSIDE BLDG 795	
DATE	FCI/M3	DATE	FCI/M3
2/15	2.78	2/16	0.00
2/18	0.00	2/17	0.00
2/21	8.78	2/18	4.83
2/25	0.00	2/20	0.00
2/27	0.00	2/22	0.00
2/27	2.67	2/23	0.00
3/3	1.58	2/24	0.00
3/4	5.16	3/2	0.00
3/7	0.00		
3/7	0.00		
3/7	0.00		